CERTIFICATE

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[Title of the Invention] LIQUID CRYSTAL DEVICE, METHOD FOR MAKING THE SAME, AND ELECTRONIC DEVICE

[Claims]

[Claim 1] A liquid crystal device comprising a first substrate and a second substrate bonded to each other with a sealant at a gap and a liquid crystal enclosed in the gap, the liquid crystal device further comprising:

a first transparent electrode provided on the inner face opposing the second substrate of the first substrate;

a reflective film which is formed in the interior of the frame of the sealant and which contains elemental silver or a silver alloy containing silver;

an insulating protective film formed so as to cover the reflective film;

a reflective conductive film which is formed in the exterior of the frame of the sealant and which contains elemental silver or a silver alloy containing silver, the crystal grains thereof being larger than the crystal grains in the reflective film;

a second transparent electrode formed on the protective film so as to face the first transparent electrode; and

a transparent conductive film formed by patterning the same layer as that for the second transparent electrode so as to cover the reflective conductive film.

[Claim 2] A liquid crystal device according to claim 1,

wherein the protective film protects the reflective film and reflects blue light components.

[Claim 3] A liquid crystal device according to claim 1,

wherein the reflective film is patterned such that the reflective film has substantially the same shape as that of the second transparent electrode lying on the reflective film at the same position as that of the reflective film.

[Claim 4] A liquid crystal device according to claim 1,

wherein the reflective film is provided with an opening at the position corresponding to the crossing between the first transparent electrode and the second transparent electrode.

[Claim 5] A liquid crystal device according to claim 1,

wherein the first transparent electrode is connected to a lead formed on the second substrate via a conductor provided between the two substrates; and

the lead comprises a laminate film of the reflective conductive film and the transparent conductive film.

[Claim 6] A liquid crystal device according to claim 5,

wherein a semiconductor device for driving at least the first transparent electrode via the lead is mounted on the inner face of the second substrate.

[Claim 7] An electronic device comprising a liquid crystal device according to any one of claims 1 to 6.

[Claim 8] A method for making a liquid crystal device comprising a first substrate and a second substrate, the electrode-forming faces thereof being bonded to each other with a predetermined gap and a liquid crystal being enclosed in the gap, the method comprising the steps of:

providing an underlying film on the inner face opposing the first substrate of the second substrate;

forming a reflective film comprising elemental silver or a silver alloy containing silver on the underlying film in the interior of the frame of the sealant;

forming an insulating protective film so as to cover the reflective film;

forming a reflective conductive film comprising elemental silver or a silver alloy containing silver in the exterior of the frame of the sealant so that the crystal grains thereof are larger than the crystal grains in the reflective film; and

patterning a transparent conductive layer to form the second transparent electrode in the interior of the frame of the sealant and a transparent conductive film in the exterior of the frame of the sealant so as to cover the reflective conductive film.

[Claim 9] A method for making a liquid crystal device comprising a first substrate and a second substrate, the electrode-forming faces thereof being bonded to each other

with a predetermined gap and a liquid crystal being enclosed in the gap, the method comprising the steps of:

providing an underlying film on the inner face opposing the first substrate of the second substrate;

patterning a conductive layer comprising elemental silver or a silver alloy containing silver on the underlying film to form reflective film in the interior of the frame of the sealant and a reflective conductive film in the exterior of the frame of the sealant;

forming an insulating protective film so as to cover the reflective film;

annealing the second substrate; and

patterning a transparent conductive layer to form the second transparent electrode in the interior of the frame of the sealant and a transparent conductive film in the exterior of the frame of the sealant so as to cover the reflective conductive film.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to reflective and transflective liquid crystal devices which use silver alloys and the like to reflect light, to a method for making the same, and to electrooptical devices using the liquid crystal devices as display sections.

[0002]

[Description of the Related Art]

As is well known, liquid crystal devices do not emit light but performs display by controlling the polarization state of light. Thus, it is necessary that the configuration be such that light is incident on a panel of the liquid crystal device, and in this regard, they are quite different from other display devices, such as electroluminescent devices and plasma display devices.

[0003]

Herein, the liquid crystal devices are classified into two types, that is, a transmissive type in which a light source is provided behind the panel and the light passing through the panel is observed by a viewer, and a reflective type in which a light source is provided on the front side of the panel (or the light source is not provided) and the light incident from a viewer side and reflected by a panel is observed by a viewer.

[0004]

In the transmissive type, the light emitted from the light source provided at the rear side of the panel (thus, called backlight) is introduced to the entire panel through a light guide plate. Then, the light passes through a polarizer, a back substrate, an electrode, a liquid crystal, another electrode, a viewer-side substrate, and another

polarizer and is observed by the observer. On the other hand, in the reflective type, the light incident on the panel passes through a polarizer, a viewer-side substrate, an electrode, a liquid crystal, and another electrode, is reflected by a reflective film, and passes through the path in the reverse direction, and is observed by a viewer. Thus, the reflective type has twice the optical path including an incident path and a reflected path and large optical losses occur in both paths. Compared to the transmissive type, the amount of light from the surrounding environment (external light) is less than that of a light source disposed at the rear side of the panel. Since only a small amount of light is observed by the viewer, the display is dim. However, the reflective type also has noticeable advantages, such as high outdoor visibility under sunlight and an ability to display without a light source, compared with the transmissive type. Thus, the reflective liquid crystal devices are widely used in display sections of portable electronic devices and the like.

[0005]

The reflective type, however, has a notable disadvantage in that the viewer cannot see the display when insufficient natural illumination is provided from the environment. In recent years, a transflective type has appeared in which a backlight is provided at the rear face

of a panel, and a reflective film not only reflects the light incident from the viewer's side and but also transmits some of the light from the rear face. This transflective type functions both as a transmissive type by switching on the backlight to ensure visibility of the display when there is insufficient external light and as a reflective type by extinguishing the backlight in order to reduce power consumption when there is sufficient external light. This means, the transmissive type or the reflective type is selected depending on the intensity of the external light to ensure visibility of the display and to reduce power consumption.

[0006]

In the reflective type and the transflective type, aluminum has been generally used as a material for the reflective film. However, in recent years, the use of elemental silver or a silver alloy primarily composed of silver (hereinafter referred to as merely "silver alloy") has been investigated to improve reflectance for achieving bright display. Since the silver alloy exhibits superior conductivity in addition to the reflectance, it has been investigated that this is used in leads on substrates.

[0007]

[Problems to be Solved by the Invention]

However, in a liquid crystal device, a problem arises

in that the reflectance of the reflective film formed of the silver alloy decreases when the film is subjected to any high-temperature treatment.

[0008]

The present invention has been realized in view of the above circumstances. It is an object thereof to provide a liquid crystal device having a reflective film of a silver alloy in which a decrease in reflectance does not occur during a high-temperature treatment, a method for making the device, and an electronic device.

[0009]

[Means for Solving the Problems]

The present inventor concluded that a decrease in reflectance of the reflective film which is composed of a silver alloy during the high-temperature treatment is caused by the crystal grain (grain scale) growth in the reflective film during the high-temperature treatment.

[0010]

A liquid crystal device in accordance with the present invention comprises a first substrate and a second substrate bonded to each other with a sealant at a gap and a liquid crystal enclosed in the gap. The liquid crystal device further comprises a first transparent electrode provided on the inner face opposing the second substrate of the first substrate, a reflective film which is formed in the interior

of the frame of the sealant and which contains elemental silver or a silver alloy containing silver, an insulating protective film formed so as to cover the reflective film, a reflective conductive film which is formed in the exterior of the frame of the sealant and which contains elemental silver or a silver alloy containing silver, the crystal grains thereof being larger than the crystal grains in the reflective film, a second transparent electrode formed on the protective film so as to face the first transparent electrode, and a transparent conductive film formed by patterning the same layer as that for the second transparent electrode so as to cover the reflective conductive film.

[0011]

According to this configuration, the reflective film formed of the silver alloy is entirely covered by the protective film. Since the growth of the crystal grains constituting the reflective film is suppressed by the protective film, a decrease in reflectance is prevented. On the other hand, the resistance of the lead can be decreased in the reflective conductive film in the exterior of the frame of the sealant by growing the crystal grains or using large crystal grains, because a decrease in reflectance does not arise problems.

[0012]

Meanwhile, the reflectance of silver or a silver alloy

is superior in the entire visible light region, but is not so flat as that of aluminum and tends to decrease at the shorter wavelength side (see Fig. **). As a result, the light reflected by the reflective film less contains blue light components and thus is yellowish. Thus, it is preferable in the present invention that the protective film protects the reflective film and reflects the blue light components. Since large amounts of blue light components are reflected by the protective film before the components are reflected by the reflective film, the reflected light is not yellowish.

[0013]

In the present invention, the reflective film is covered by the insulating protective film. If the reflective film is applied to the entire surface, two adjoining second transparent electrodes formed on the protective film are readily electrically coupled with each other via the reflective film. Thus, it is preferable that the reflective film be patterned such that the reflective film has substantially the same shape as that of the second transparent electrode lying on the reflective film at the same position as that of the reflective film. According to this configuration, the adjoining second transparent electrodes are barely electrically coupled with each other via the reflective film, suppressing a decrease in display

image.

[0014]

In the present invention, the reflective film is preferably provided with an opening at the position corresponding to the crossing between the first transparent electrode and the second transparent electrode. This configuration enables display not only by the light reflected by the reflective film but also by the light passing through the opening.

[0015]

Preferably, the first transparent electrode is connected to a lead formed on the second substrate via a conductor provided between the two substrates, and the lead comprises a laminate film of the reflective conductive film and the transparent conductive film. According to this configuration, the first transparent electrode provided on the first substrate can be provided on the second substrate provided with the second transparent electrode. Since an external circuit is connected to only the second substrate, the connection process can be simplified. Since the lead consists of a laminate film of the reflective conductive film and the transparent conductive film, the resistance thereof is lower than that of a single layer.

[0016]

In a configuration provided with the lead composed of

such a laminate film, preferably, a semiconductor device for driving at least the first transparent electrode via the lead is mounted on the inner face of the second substrate. Such mounting of the semiconductor device can reduce connection points to the external circuit.

[0017]

Since an electronic device in accordance with the present invention is provided with the above liquid crystal device in the display section, bright reflective display can be achieved without a decrease in reflectance of the reflective film during a high-temperature treatment after the reflective film is formed.

[0018]

In order to achieve the above object, in a method for making a liquid crystal device in accordance with the present invention comprising a first substrate and a second substrate, the electrode-forming faces thereof being bonded to each other with a predetermined gap and a liquid crystal being enclosed in the gap, the method comprises the steps of providing an underlying film on the inner face opposing the first substrate of the second substrate, forming a reflective film comprising elemental silver or a silver alloy containing silver on the underlying film in the interior of the frame of the sealant, forming an insulating protective film so as to cover the reflective film, forming

a reflective conductive film comprising elemental silver or a silver alloy containing silver in the exterior of the frame of the sealant so that the crystal grains thereof are larger than the crystal grains in the reflective film, and patterning a transparent conductive layer to form the second transparent electrode in the interior of the frame of the sealant and a transparent conductive film in the exterior of the frame of the sealant so as to cover the reflective conductive film.

[0019]

According to this method, the reflective film is entirely covered by the protective film. Since the growth of the crystal grains constituting the reflective film is suppressed by the protective film during the high-temperature treatment after the reflective film is formed, a decrease in reflectance is prevented. Since a decrease in reflectance in the reflective conductive film in the exterior of the frame of the sealant does not arise problems, the wiring resistance can be reduced by using large crystal grains.

[0020]

In order to achieve the above object, in a method for making a liquid crystal device in accordance with the present invention comprising a first substrate and a second substrate, the electrode-forming faces thereof being bonded

to each other with a predetermined gap and a liquid crystal being enclosed in the gap, the method comprises the steps of providing an underlying film on the inner face opposing the first substrate of the second substrate, patterning a conductive layer comprising elemental silver or a silver alloy containing silver on the underlying film to form reflective film in the interior of the frame of the sealant and a reflective conductive film in the exterior of the frame of the sealant, forming an insulating protective film so as to cover the reflective film, annealing the second substrate, and patterning a transparent conductive layer to form the second transparent electrode in the interior of the frame of the sealant and a transparent conductive film in the exterior of the frame of the sealant so as to cover the reflective conductive film.

[0021]

According to this method, the silver alloy can be deposited by only one step. Moreover, the reflective film in the interior of the frame of the seal is entirely covered by the protective film. Since the growth of the crystal grains constituting the reflective film is suppressed by the protective film, a decrease in reflectance is prevented. In contrast, the crystal grains are grown in the reflective conductive film in the exterior of the frame of the sealant during the high-temperature treatment, hence, the wiring

resistance can be reduced.

[0022]

[Description of the Embodiments]

The Embodiments of the present invention will be described with reference to the drawings.

[0023]

<First Embodiment>

A liquid crystal device in accordance with a first embodiment of the present invention will now be described. This liquid crystal device is of a transflective type which functions as a reflective type when external light is sufficient and as a transmissive type by switching on a backlight when the external light is insufficient.

[0024]

<Overall Configuration>

Fig. 1 is an isometric view illustrating an overall configuration of a liquid crystal panel in the liquid crystal device. Fig. 2 is a partial cross-sectional view when the device is broken along the X direction in Fig. 1, and Fig. 3 is a partial cross-sectional view when the device is broken along the Y direction in Fig. 1.

[0025]

As shown in these drawings, the liquid crystal panel 100 constituting the liquid crystal device includes a viewer-side substrate (first substrate) 200 lying at the

viewer side and a backside substrate (second substrate) 300 lying at the back side, these substrates being bonded to each other at a predetermined gap with a sealant 110 which contains conductive particles 114 and also functions as a spacer. This gap is filled with, for example, a twisted nematic (TN) liquid crystal 160. The sealant 110 is formed on either substrate to form a frame along the peripheries of the inner face of the viewer-side substrate 200 and has an opening for enclosing the liquid crystal 160. This opening is sealed with a sealant 112 after the liquid crystal is enclosed.

[0026]

A plurality of common electrodes (first transparent electrodes) 214 extends in the X direction on the inner face of the viewer-side substrate 200, whereas a plurality of segment electrodes (second transparent electrodes) 314 extends in the Y direction on the inner face of the backside substrate 300. In this embodiment, a voltage is applied to the liquid crystal 160 through these electrodes at regions in which the segment electrodes 314 and the common electrodes 214 cross each other and these crossing regions function as sub-pixels.

[0027]

In the backside substrate 300, a driver IC chip (semiconductor device) 122 for driving the common electrodes

214 and a driver IC chip 124 for driving the segment electrodes 314 are mounted on two sides which protrude from the viewer-side substrate 200 by a chip-on-glass (COG) technology, as described below. At the exterior of the region for mounting the driver IC chip 124 in these two sides, a flexible printed circuit (FPC) board 150 is bonded.

[0028]

Each common electrode 214 formed on the viewer-side substrate 200 is connected to one end of each lead 350 which is formed on the backside substrate 300, via conductive particles 114 contained in the sealant 110. On the other hand, the other end of the lead 350 is connected to an output terminal of the driver IC chip 122. That is, the driver IC chip 122 supplies common signals through the leads 350, the conductive particles 114, and the common electrodes 214 in that order. Input terminals of the driver IC chip 122 and the FPC board 150 are connected to each other with leads 360.

[0029]

The segment electrodes 314 formed on the backside substrate 300 are connected to the output terminal of the driver IC chip 124. That is, the driver IC chip 124 directly supplies segment signals to the segment electrodes 314. The input terminal of the driver IC chip 124 and the FPC board 150 are connected with leads 370.

[0030]

As shown in Figs. 2 and 3, in the liquid crystal panel 100, a polarizer 121 and a retarder 123 are provided on the proximal side (viewer side) of the viewer-side substrate 200. Furthermore, a polarizer 131 and a retarder 133 are provided on the backside (away from the viewer) of the backside substrate 300 (not shown in Fig. 1). In addition, a backlight (not shown in the drawings) is provided behind the backside substrate 300 so that the liquid crystal device is used as a transmissive type when the external light is insufficient.

[0031]

<Display Region>

A display region in the liquid crystal panel 100 will now be described in detail. The viewer-side substrate 200 will be described in detail. As shown in Figs. 2 and 3, the retarder 123 and the polarizer 121 are bonded onto the outer face of the viewer-side substrate 200. The inner face of the viewer-side substrate 200 is provided with a shading film 202 to prevent color mixing between sub-pixels and to function as a frame defining the display region. Moreover, color filters 204 are arranged into a predetermined array corresponding to crossing regions between the common electrodes 214 and the segment electrodes 314 (corresponding to openings of the shading film 202). In this embodiment,

red (R), green (G), and blue (B) color filters 204 have a stripe arrangement which is suitable for displaying data (see Fig. 4), and three R, G, and B sub-pixels constitute one substantially square pixel. However, the present invention is not limited to this configuration.

[0032]

A planarization film 205 formed of an insulating material planarizes steps between the shading film 202 and the color filters 204, and a plurality of strip common electrodes 214 composed of a transparent conductive material such as ITO extends in the X direction (the transverse direction in Fig. 2 and the longitudinal direction in Fig. 3) on the planarized plane. This alignment film 208 is subjected to rubbing treatment in a predetermined direction before bonding to the back substrate 300. Since the alignment film 208 is unnecessary in regions other than the display region, this is not provided in the vicinity of the region of the sealant 110.

[0033]

The configuration of the backside substrate 300 will now be described. The retarder 133 and the polarizer 131 are bonded to the outer face of the backside substrate 300. Furthermore, an underlying film 301 is formed on the entire inner face of the backside substrate 300. In addition, a reflective film 302 is formed on the underlying film 301.

The reflective film 302 is formed of elemental silver or a silver alloy primarily composed of silver and is deposited by low-temperature sputtering. The reflective film 302 reflects light incident from the viewer-side substrate 200 towards the viewer-side substrate 200. Preferably, the reflective film 302 has a surface causing irregular reflection rather than a complete mirror surface. Although the reflective film 302 is preferably formed so as to have an uneven surface to some extent, the description thereof is omitted in the present invention since the description does not relates to the present invention directly. The reflective film 302 is provided with two openings 309 per one sub-pixel for transmitting light from the backlight so that the device can be used also as a transmissive type (see Fig. 4). The underlying film 301 provided on the backside substrate 300 improves adhesiveness of the overlying reflective film 302 to the substrate.

[0034]

An insulating protective film 303 is provided so as to cover the reflective film 302 provided with the openings 309. The protective film 303 protects the reflective film 302, prevents a decrease in reflectance of the reflective film 302, and reflects large amounts of blue light components of the light incident from the viewer-side substrate 200.

[0035]

In addition, strip segment electrodes 314 composed of a transparent conductive material such as ITO extend in the Y direction on the protective film 303. An alignment film 308 composed of polyimide or the like is formed on the segment electrodes 314 and the protective film 303, and is subjected to rubbing treatment in a predetermined direction before bonding to the viewer-side substrate 200.

[0036]

Since the alignment film 308 and the underlying reflective film 302 are unnecessary in regions other than the display region, these are not provided in the vicinity and the exterior of the frame of the sealant 110. A manufacturing process of the backside substrate 300 will be described in detail after various leads are described.

[0037]

<Vicinity of Sealant>

The vicinity of the region of the sealant 110 in the liquid crystal panel 100 will be described with reference to Figs. 2, 3, 4, and 5. Fig. 4 is a perspective plan view of a detailed configuration of leads in the vicinity of the side for mounting the driver IC chip 122 in the region of the sealant 110 when viewed from the viewer, and Fig. 5 is a cross-sectional view taken from line A-A′ in Fig. 4.

[0038]

The common electrodes 214 and the leads 350 will be described. As shown in these drawings, the common electrodes 214 on the viewer-side substrate 200 extend to the region of the sealant 110, whereas transparent conductive films 352 constituting the leads 350 extend to the region of the sealant 110 on the backside substrate 300 so as to face the common electrodes 214. Thus, given amounts of spherical conductive particles 114 dispersed in the sealant 110 function as spacers and electrically connect the common electrodes 214 and the corresponding transparent conductive films 354.

[0039]

Herein, as described above, each lead 350 electrically connects the corresponding common electrode 214 and the output terminal of the driver IC chip 122 at the backside substrate 300 and has a laminate configuration of a reflective conductive film 352 and the corresponding transparent conductive film 354. The reflective conductive film 352 is formed by patterning a conductive layer of elemental silver or a silver alloy primarily composed of silver which is deposited by high-temperature sputtering or the like. That is, the reflective conductive film 352 and the reflective film 302 in this embodiment are common with regard to patterning of conductive layers composed of the silver alloy, but are different in deposition process. The

transparent conductive films 354 are formed by patterning the conductive layer of ITO or the like which is the same as that of the segment electrodes 314 so as to be one size larger than the reflective conductive films 352 and, in detail, as shown in Fig. 5, so as to come into contact with the protective film 303 at the edge portion. As shown in Figs. 2, 3, and 4, the reflective conductive films 352 are not formed and only the transparent conductive films 354 are formed in the region for forming the sealant 110.

[0040]

Next, extraction of the segment electrodes 314 will be described. As shown in Fig. 3, each segment electrode 314 is formed on the protective film 303, is extracted to the exterior of the frame of the sealant 110, is deposited on a reflective conductive film 312 which is obtained by patterning the conductive layer of the same silver alloy as that of the reflective conductive films 352, and is extracted to the output terminal of the driver IC chip 124 as a lead 310. The segment electrode 314 is patterned so as to be one size larger than the laminated reflective conductive film 312 at the exterior of the frame of the sealant 110 and to come into contact with the protective film 303 at the edge portion protruding from the reflective conductive film 312, as shown by parentheses in Fig. 5, in cross-sectional view.

[0041]

In this embodiment, the reflective film 302 is electrically floating in the interior of the frame of the sealant 110. Thus, it is preferable that the protective film 303 be formed so that the distance between the reflective film 302 and the segment electrode 314 is approximately 2 μm and each segment electrode 314 and the reflective film 302 do not cause capacitive coupling.

[0042]

The diameter of the conductive particle 114 in Figs. 2 and 3 is larger than the actual size for description and only one particle is depicted in the width direction of the sealant 110. In the actual configuration, however, many conductive particles 114 are arranged in the width direction of the sealant 110.

[0043]

<Region for Mounting Driver IC and Vicinity of Region for Bonding FPC Board>

Next, regions for mounting the driver IC chips 122 and 124 and the vicinity of a region for connecting the FPC board 150 in the backside substrate 300 will be described. Fig. 6 is a cross-sectional view which primarily illustrates leads among configurations of these regions, and Fig. 7 is a plan view which illustrates the lead configuration in the region for mounting the driver IC chip 122, when viewed from

the viewer. Although, the backside substrate 300 is provided with the leads 350, 360 and 370, as well as the segment electrodes 312, as described above, only the leads 350 and 360 relating to the driver IC chip 122 will be described in this embodiment.

[0044]

As shown in these drawings, the leads 350 for supplying the common signal from the driver IC chip 122 to the common electrodes 214 are composed of laminate films including the reflective conductive films 352 and the transparent conductive films 354. The region for mounting the driver IC chip 122, however, includes only the transparent conductive film 354 and does not include the reflective conductive film 352, as in the region for forming the sealant 110.

[0045]

Each lead 360 for supplying various signals, fed from the FPC board 150, to the driver IC chip 122 is composed of a laminate film including a reflective conductive film 362 and a transparent conductive film 364, like the lead 350. The reflective conductive film 362 is formed by patterning the conductive layer of a silver alloy which is the same as the layer for the reflective conductive film 352. The transparent conductive film 364 is formed by patterning the conductive layer of ITO or the like which is the same as the layer for the segment electrodes 314 and the transparent

conductive films 354 such that the transparent conductive film 364 is one size larger than the reflective conductive film 362 and more specifically such that the edge portion of the transparent conductive film 364 protruding from the reflective conductive film 362 comes into contact with the protective film 303, as shown in parentheses in Fig. 5, in cross-sectional view. In the region for mounting the driver IC chip 122 and the region for bonding the FPC board 150 (not shown in Fig. 7), the leads 360 are provided with only the transparent conductive film 364 and thus not provided with the reflective conductive film 362.

[0046]

The driver IC chip 122 is COG-mounted to the leads 350 and 360, for example, by the following process. A plurality of electrodes is provided at the periphery of a face of the rectangular parallelepiped driver IC chip 122. A projection electrode (bump) 129a or 129b composed of, for example, gold (Au) is preliminarily formed to each electrode. Then, an anisotropic conductive sheet of an adhesive 130, such as an epoxy adhesive, containing uniformly dispersed conductive particles 134 is placed onto the region for mounting the driver IC chip 122 on the backside substrate 300. The anisotropic conductive sheet is sandwiched by the driver IC chip 122 in which the face provided with the electrodes is arranged at the inner side and the backside substrate 300.

After the driver IC chip 122 is positioned, pressure and heat are applied to the backside substrate 300 via the anisotropic conductive sheet.

[0047]

As a result, in the driver IC chip 122, the projection electrode 129a and the projection electrode 129b are electrically connected to the transparent conductive films 354 constituting the leads 350 and the transparent conductive films 364 constituting the leads 360, respectively, via the conductive particles 134 in the adhesive 130. The adhesive 130 also functions as a sealant which protects the electrode-forming-face of the driver IC chip 122 from moisture, contamination, stress, etc.

[0048]

The leads 350 and 360 relating to the driver IC chip 122 are exemplified above. Leads relating to the driver IC chip 124, that is, the leads 310 relating to the driver IC chip 124 and the leads 370 supplying various signals fed from the FPC board 150 to the driver IC chip 124 have substantially the same configurations as those of the leads 350 and 360, as shown in parentheses in Fig. 6.

[0049]

That is, in the exterior of the frame of the sealant 110, the segment electrodes 314 for supplying the segment signals from the driver IC chip 124 are formed of laminate

films of the reflective conductive films 312 and the transparent conductive films 314, as described above. In the region for mounting the driver IC chip 124, only the transparent conductive film of the segment electrode 314 is provided and the reflective conductive film 312 is not provided.

[0050]

Similarly, the leads 370 for supplying various signals fed from the FPC board 150 to the driver IC chip 124 is composed of a laminate of a reflective conductive film 372 and a transparent conductive film 374. The reflective conductive film 372 is formed by patterning the same conductive layer of a silver alloy as that for the reflective conductive films 352 and 362. The transparent conductive film 374 is formed by patterning the same conductive layer of ITO or the like as that for the transparent conductive films 354 and 364 such that the transparent conductive film 374 is one size larger than the reflective conductive film 372 and the edge thereof protruding from the reflective conductive film 372 comes into contact with the protective film 303 shown in parentheses in Fig. 5, in cross-sectional view.

[0051]

In the region for mounting the driver IC chip 124 and the region for bonding the FPC board 150, only the

transparent conductive film 374 of the lead 370 is provided and the reflective conductive film 372 is not provided.

[0052]

These leads 310 and 370 of such laminate films are connected to the driver IC chip 124 via the anisotropic conductive sheet, as in the driver IC chip 122.

[0053]

The anisotropic conductive sheet is also used for connection of the FPC board 150 to the leads 360 and 370. A lead 154 formed on a substrate 152 of polyimide or the like of the FPC board 150 is electrically connected to the transparent conductive film 364 constituting the lead 360 and the transparent conductive film 374 constituting the lead 370 via conductive particles 144 in an adhesive 140.

[0054]

<Manufacturing Process>

A manufacturing process of the above liquid crystal device and particularly of the backside substrate will be described with reference to Figs. 8 and 9. The description is mainly focused to the segment electrode 314 and the lead 350 and the interior (display region) of the sealant frame, the sealant, and the exterior of the sealant frame are separately described.

[0055]

As shown in Fig. 8(a), Ta_2O_5, SiO_2, or the like is

deposited on the entire inner face of a backside substrate 300 by sputtering to form an underlying film 301. As shown in Fig. 8(b), a reflective conductive layer 302′ composed of elemental silver or primarily composed of silver is deposited by sputtering or the like at a relatively low temperature (approximately 200°C). The reflective film 302' is composed of, for example, an alloy containing approximately 98% silver (Ag), platinum (Pt), and copper (Cu) by weight in this embodiment, an alloy containing silver, copper, and gold, or an alloy containing silver, ruthenium (Ru), and copper. Then, as shown in Fig. 8(c), the reflective film 302' is patterned by photolithographic and etching processes to form an opening 309 and a reflective film 302.

[0056]

As shown in Fig. 8(d), a protective film 303 is formed using a dielectric laminate or SiO_2 in the interior of the sealant frame to cover the reflective film 302. As shown in Fig. 8(e), a reflective conductive film 352' composed of elemental silver or primarily composed of silver is deposited on the protective film 303 by sputtering or the like at a relatively high temperature (approximately 400°C). The reflective conductive film 352' is preferably composed of the silver-palladium-copper alloy, the silver-copper-gold alloy, or the silver-ruthenium-copper alloy, like the

reflective film 302′ for forming the reflective film 302. As shown in Fig. 9(f), the reflective conductive film 352′ is patterned by photolithographic and etching processes to form a reflective conductive film 352 constituting leads 350, and reflective conductive films 362 and 372 constituting leads 360 and 370, respectively. As shown in Fig. 9(g), a transparent conductive layer 314′ of ITO or the like is deposited by a sputtering or ion plating process.

[0057]

As shown in Fig. 9(h), the segment electrode 314′ is patterned by photolithographic and etching processes to form segment electrodes 314 in the interior of the sealant frame and transparent conductive film 354 and the reflective conductive films 314, 364, and 374 in the exterior of the sealant frame. The peripheries of the segment electrode 314 and the transparent conductive films 354, 364, and 374 are not removed so as to come into contact with the protective film 303 such that the reflective conductive films 352, 362, and 372 are not exposed. Since the surfaces of the reflective conductive films 312, 352, 362, and 372 are thereby not exposed after the conductive layer 314′ is deposited, these layers are prevented from corrosion and separation.

[0058]

As shown in Fig. 9(i), the alignment film 308 of an

organic film such as polyimide is formed in the interior of the sealant frame and the alignment film 308 is subjected to rubbing treatment. In the subsequent steps (not shown in the drawings), the viewer-side substrate 200 and a backside substrate 300 having a rubbing-treated alignment film 208 are bonded to each other with the sealant 110 containing adequately dispersed conductive particles 114. A liquid crystal 160 is dropwise supplied to the opening of the sealant 110 under vacuum. After the pressure is backed to normal pressure so that the liquid crystal 160 spreads over the interior of the sealant frame, the opening is sealed with a sealant 112. As described above, the driver IC chips 122 and 124 and the FPC board 150 are mounted to complete the liquid crystal panel 100 shown in Fig. 1.

[0059]

In such a manufacturing method, the reflective film 302′ forming the reflective film 302 is deposited at a low temperature in Fig. 8(b); hence, the reflectance thereof is high. Although this film is treated at a relatively high temperature in Fig. 8(e), crystal grain growth in the reflective film 302 covered by the protective film 303 is suppressed, preventing a decrease in reflectance of the reflective film 302. In contrast, the reflective conductive film 352′ forming the reflective conductive film 352 is deposited at a high temperature. Since the crystal grain

size in the reflective conductive film 352' increases, the lead resistance thereof decreases. Accordingly, in this embodiment, the reflective film 302 maintains high reflectance while the reflective conductive films 352, 362, and 372 exhibit reduced lead resistance. Although the reflectance of the reflective conductive films 352, 362, and 372 decreases due to the crystal grain growth, a decrease in reflectance does not arise problems, since the reflective conductive films 352, 362, and 372 are used as lead layers not as reflective films.

[0060]

<Display Operation, etc.>

The display operation of the liquid crystal device in accordance with such a configuration will be described in brief. The driver IC chip 122 applies a selection voltage to common electrodes 214 in a predetermined order every horizontal scanning period, while the driver IC chip 124 supplies segment signals corresponding to the display information of one sub-pixel line which lies at these common electrodes 214 to the corresponding segment electrodes 314. The alignment of the liquid crystal 160 in the sub-pixels in this region is independently controlled based on the differences between the voltages applied to the common electrodes 214 and the voltages applied to the segment electrodes 314.

[0061]

With reference to Figs. 2 and 3, the external light from the viewer passes through the polarizer 121 and the retarder 123 to be polarized to a predetermined state. The light passes through the viewer-side substrate 200, the color filters 204, the common electrodes 214, the liquid crystal 160, the segment electrodes 314, and the protective film 303, and reaches the reflective film 302. The light is reflected thereby and passes through the above route backward. Thus, in the reflective type, the amount of the light which is reflected by the reflective film 302, passes through the polarizer 121, and is visible by the viewer is independently controlled in each sub-pixel in response to a change in alignment of the liquid crystal 160 between the common electrode 214 and the segment electrode 314.

[0062]

In the reflective type, a larger amount of shorter-wavelength (blue) light is reflected by the protective film 303 which lies above the reflective film 302 rather than by the reflective film 302. The reason for providing the protective film 303 in this embodiment is as follows. As shown in Fig. 10, the reflectance of silver or a silver alloy is superior in the entire visible light region, but is not so flat as that of aluminum and tends to decrease at the shorter wavelength side. As a result, the light reflected

by the reflective film 302 less contains blue light components and thus is yellowish. Thus, color reproducibility would be adversely affected in a color display mode. Thus, the protective film 303 is provided so that large amounts of blue light components are reflected by the protective film 303 rather than by the reflective film 302.

[0063]

When a backlight (not shown in the drawing) lying at the rear face of the backside substrate is turned on, the light from the backlight passes through the polarizer 131 and the retarder 133 and is polarized to a predetermined state. The light further passes through the backside substrate 300, the openings 309, the protective film 303, the segment electrodes 314, the liquid crystal 160, the common electrodes 214, the color filters 204, the viewer-side substrate 200, and the polarizer 121, and is emitted towards the viewer. Thus, also, in the transmissive type, the amount of the light which passes through the openings 309 and the polarizer 121 and is observed by the viewer is independently controlled in each sub-pixel by a change in alignment of the liquid crystal 160 between the common electrodes 214 and the segment electrode 314.

[0064]

Since the liquid crystal device in accordance with this

embodiment functions as a reflective type when the external light is sufficient and a transmissive type by switching on the backlight when the external light is insufficient, and thus can perform display in both types. Since the reflective film 302 reflecting the light is formed of a silver alloy primarily composed of silver and is covered by the protective film 303 so as to moderate crystal grain growth in the silver alloy constituting the reflective film 302, light returning towards the viewer is increased due to high reflectance. Accordingly, this liquid crystal device performs bright display when this functions as a reflective type.

[0065]

Since the leads 350, 360, and 370 have laminate configurations which include the transparent conductive films 354, 364, and 374, respectively, and the reflective conductive films 352, 362, and 372, respectively, which are composed of the same conductive layer as the reflective film 302, these leads exhibit lower resistance than that when these leads are composed of a single layer. Since the reflective conductive films 352, 362, and 372 are formed by patterning the conductive film 352′ which is deposited by high-temperature sputtering, the average grain diameter of the crystal is large. Thus, the reflective conductive films 352, 362, and 372 have further reduced resistance compared

with that of the reflective film 302 of a silver alloy. Since the segment electrodes 314 are also laminated with the reflective conductive films 312 at the exterior of the sealant frame, these have reduced resistance.

[0066]

Since the segment electrodes 314 and the transparent conductive films 354, 364, and 374 cover the reflective conductive films 312, 352, 364, and 374, respectively, so that these layers are not exposed, corrosion and the like due to moisture penetration is prevented, thus enhancing reliability.

[0067]

In the region for mounting the driver IC chip 124, the segment electrodes 314 are not provided with the transparent conductive film 312. In the region contained in the sealant 110 and the region for mounting the driver IC chip 122, the leads 350 are provided with only the transparent conductive films 354 and thus not provided with the reflective conductive films 352. In the region for mounting the driver IC chip 122 and the region for connecting the FPC board 150, the leads 360 are provided with only the transparent conductive film 364 and thus not provided with the reflective conductive film 362. In the region for mounting the driver IC chip 124 and the region for connecting the FPC board 150, the leads 370 are provided with only the

transparent conductive film 374 and thus not provided with the reflective conductive film 372.

[0068]

Since the silver alloy exhibits poor adhesiveness to other materials, it is not desirable that this alloy be provided at portions in which stress is applied. If a decrease in resistance of the leads has priority, it is preferable that the reflective conductive film be formed over the entire underlayer of the segment electrode or the transparent conductive film. In such a configuration, however, insufficient connection of the driver IC in the mounting step may cause separation of the reflective conductive film from the substrate due to low adhesiveness, for example, when the driver IC chip is exchanged due to unsatisfactory connection. Moreover, the conductive particles 114, 134, and 144 are composed of nonconductive particles of plastic or the like of which the surfaces are covered by a metal such as gold (Au). This covering metal exhibits superior adhesiveness to a transparent conductive single layer. Thus, in this embodiment, only the transparent conductive film of ITO or the like is deposited and a reflective conductive film of a silver alloy is not deposited in the region included in the sealant 110, the regions for mounting the driver IC chips 122 and 124, and the region for bonding the FPC board 150.

[0069]

Since the common electrodes 214 provided on the viewer-side substrate 200 are extracted to the backside substrate 300 via the conductive particles 114 and the leads 350, and are further extracted to the connection to the FPC board 150 via the leads 360, the connection of the FPC board 150 is achieved on one side regardless of a passive matrix type in this embodiment. Thus, the mounting process is simplified.

[0070]

<Second Embodiment>

In the above first embodiment, the reflective film 302 (conductive layer 302') having high reflectance is formed by low-temperature sputtering, whereas the reflective conductive films 312, 352, 362, and 372 (conductive film 352') having low wiring resistance are formed by high-temperature sputtering. Since the deposition of the silver alloy requires both low-temperature sputtering and high-temperature sputtering in the first embodiment, the manufacturing process is complicated. Thus, a second embodiment which can deposit silver alloy films by one step will now be described.

[0071]

In a liquid crystal device in accordance with the second embodiment, the overall configuration of the liquid crystal panel 100 is similar to that in the first embodiment

(see Fig. 1), but the internal structures are slightly different from each other. Configurations taken along the X direction and the Y direction are shown in Figs. 11 and 12, respectively. A difference from the first embodiment shown in Figs. 2 and 3 is that the protective film 303 is not provided in the sealant frame and the exterior than the sealant frame, and thus is provided only in the interior than the sealant frame so as to cover the reflective films 302. Since the other configurations are the same as those in the first embodiment, the description thereof is omitted.

[0072]

A manufacturing process of the liquid crystal device according to the second embodiment and particularly of the backside substrate will now be described with reference to Figs. 13 and 14. The description is focused to the segment electrode 314 and the lead 350 in this process, and the sealant and the exterior of the sealant frame are separately described. Since the steps of up to depositing the conductive film 302′ forming the reflective film 302 on the underlying film 301 by low-temperature sputtering in the second embodiment are the same as those in the first embodiment (see Figs. 8(a) and 8(b)), the subsequent steps will be primarily described.

[0073]

As shown in Fig. 13(c), the conductive layer 302′

deposited by low-temperature sputtering is patterned by a photolithographic process and an etching process to form the openings 309 and the reflective films 302 in the interior of the sealant frame and the reflective conductive films 352 and the reflective conductive films 312, 362, and 372 in the exterior of the sealant frame.

[0074]

As shown in Fig. 13(d), a protective film 303 is formed using a dielectric laminate or SiO_2 in the interior of the sealant frame to cover the reflective films 302. This is annealed at a temperature of approximately 400°C. Since crystal grains of a silver alloy constituting the reflective films 302 are pressed by the protective film 303, the crystal grains do not grow, the reflectance of the reflective film 302 being not decreased. In contrast, the crystal grains in the silver alloy constituting the reflective conductive films 312, 352, 362, and 372 grow, the lead resistance thereof decreases although the reflectance thereof decreases.

[0075]

The subsequent steps are the same as those in Figs. 9(g), 9(h), and 9(i) in the first embodiment. As shown in Fig. 13(f), the transparent conductive layer 314' of ITO or the like is deposited by a sputtering process or an ion plating process. Next, as shown in Fig. 14(g), the

transparent conductive layer 314′ is patterned so as to cover the reflective conductive films 312, 352, 362, and 372 in order to form the segment electrodes 314 and the transparent conductive films 354, 354, and 374, respectively. Then, as shown in Fig. 16(h), the alignment film 308 of an organic film such as polyimide is formed in the interior of the sealant frame and the alignment film 308 is subjected to rubbing treatment.

[0076]

As in the first embodiment, the viewer-side substrate 200 and the backside substrate 300 are bonded to each other, the liquid crystal 160 is enclosed and sealed, and the driver IC chips 122 and 124 and the FPC board 150 are mounted. The liquid crystal panel 100 in the second embodiment is thereby formed. The display operation is substantially the same as that in the first embodiment.

[0077]

In the second embodiment, the reflective conductive films 312, 352, 362, and 372 are formed by patterning the conductive layer 302′ of a silver alloy constituting the reflective film 302, and the crystal grains are grown by the subsequent annealing treatment. Thus, these films have lower resistance than that of the reflective film 302. On the other hand, the reflective film 302 is covered by the protective film 303 and the reflectance thereof is not

decreased since the crystal grain growth is moderated. According to the second embodiment, the manufacturing process can be simplified since the silver alloy film such as the reflective film and the reflective conductive film can be deposited by one step, in addition to the advantages in the first embodiment, that is, the reflectance of the reflective film 302 is maintained and the lead resistance of the reflective conductive films 312, 352, 362, and 372 is reduced.

[0078]

<Various Applications>

In the above embodiment, the common electrodes 214 are driven by the driver IC chip 122 and the segment electrodes 314 are driven by the driver IC chip 124. The present invention, however, is not limited to this configuration. For example, the present invention is applicable to a one-chip type including both ICs, as shown in Fig. 15.

[0079]

The liquid crystal device shown in this drawing has a plurality of common electrodes 214 extending in the X direction on the viewer-side substrate 200 as in the other embodiments, but differs from these embodiments in that the upper half common electrodes 214 and the lower half common electrodes 214 are extracted from the left and the right, respectively, via the leads 350 and are connected to a

driver IC chip 126. The driver IC chip 126 is a one-chip IC including the driver IC chip 122 and the driver IC chip 124 in the above embodiments, and is connected to the segment electrodes 314 in the exterior of the frame of the sealant 110. Although each lead 310 is a laminate of the reflective conductive film 312 and the segment electrode 314 in the exterior of the sealant frame, the driver IC chip 126 is connected to the segment electrodes 314 in the region of the connection with the driver IC chip 126 since the reflective conductive film 312 is not deposited in this region. The FPC board 150 supplies signals for controlling the driver IC chip 126 from an external circuit (not shown in the drawing) via the leads 360 (370). In the liquid crystal device shown in Fig. 15, the common electrodes 214 may be extracted from one side if the number of the common electrodes 214 is small.

[0080]

As shown in Fig. 16, the present invention is also applicable to a type in which the driver IC chip 126 is not mounted on the liquid crystal panel 100. In the liquid crystal device shown in this drawing, the driver IC chip 126 is mounted on the FPC board 150 by, for example, a flip chip technology. Alternatively, the driver IC chip 126 may be bonded with inner leads by a tape automated bonding (TAB) technology and may be bonded to the liquid crystal panel 100

with outer leads. In such a configuration, however, the number of the connections to the FPC board 150 increases as the pixels increase.

[0081]

<Applications of Third Embodiment>

The reflective film 302 containing silver covered by the protective film 303 is electrically floating in this embodiment. Thus, the display quality may be impaired by capacitive coupling between adjoining segment electrodes 314 via the reflective film 302. Thus, the protective film 303 is formed so that the distance between the reflective film 302 and the segment electrodes 314 is approximately 2 μm to prevent capacitive coupling between the segment electrode 314. If the thick protective film 303 is not uniform in such a configuration, the display quality may be impaired due to a disordered cell gap. Thus, as shown in Fig. 17, it is preferable that the reflective film 302 and the segment electrode 314 have substantially the same width so as to overlap in plan view. When the protective film 303 is thin to some extent in such a configuration, a segment electrode 314 is capacitively coupled with the reflective film 302 beneath the same, but the adjoining segment electrode 314 is not coupled with the reflective film 302, thus preventing deterioration of display quality. In such configuration, each segment electrode 314 and the corresponding reflective

film 302 beneath the same may be physically connected to each other by providing a connection point.

[0082]

<Miscellaneous>

In the above embodiment, a transflective liquid crystal device is described. However, the present invention is also applicable to a reflective liquid crystal device not having openings 309. In the reflective type, a front light which emits light from the viewer side may be provided instead of the backlight, if necessary.

[0083]

In the above embodiments, connection between the common electrodes 214 and the leads 350 is achieved with conductive particles 114 contained in the sealant 110. However, the connection may be achieved in another region provided at the exterior of the frame of the sealant 110.

[0084]

Since the common electrode 214 and the segment electrode 314 has a mutually relative relationship, the segment electrodes may be formed on the viewer-side substrate 200 while the common electrodes may be formed on the back substrate 300.

[0085]

The liquid crystal is driven without using switching elements in the embodiment and the modification, but may be

driven by thin film diodes (TFDs) or thin film transistors (TFTs) provided in the sub-pixels. Moreover, the reflective layer 302 may be covered by the protective film 303.

[0086]

Although a TN liquid crystal is used in the above embodiment and modification, the liquid crystal device may be a bistable type having a memory effect such as a bistable twisted nematic (BTN) type and a ferroelectric type, a polymer dispersion type, or a guest-host type in which a dye (guest) having different visible light absorbencies between the long axis and the short axis of molecules is dissolved in a liquid crystal (host) having a predetermined molecular arrangement so that the dye molecules and the liquid crystal molecules are arranged in parallel. Moreover, the configuration may be a vertical (homeotropic) alignment in which the liquid crystal molecules are arranged perpendicular to the both substrates when no voltage is applied and parallel to the both substrates when a voltage is applied, or may be a parallel (homogeneous) alignment in which the liquid crystal molecules are arranged parallel to the both substrates when no voltage is applied and perpendicular to the both substrates when a voltage is applied. Accordingly, the present invention can be applied to various types of liquid crystals and alignment systems.

[0087]

<Electronic Devices>

Several electrooptical devices using the above liquid crystal device will now be described.

[0088]

<1: Mobile Computer>

An example in which the liquid crystal device according to this embodiment is applied to a mobile personal computer will now be described. Fig. 18 is an isometric view illustrating the configuration of this personal computer. In the drawing, the personal computer 1100 is provided with a body 1104 including a keyboard 1102 and a liquid crystal display unit 1106. The liquid crystal display unit 1106 is provided with a backlight (not shown in the drawing) at the back face of the above-described liquid crystal panel 100. The display is thereby visible as a reflective type when external light is sufficient or a transmissive type when external light is insufficient.

[0089]

<2: Portable Phone>

Next, an example in which the liquid crystal device is applied to a display section of a portable phone will now be described. Fig. 19 is an isometric view illustrating the configuration of the portable phone. In the drawing, the portable phone 1200 is provided with a plurality of operation keys 1202, an earpiece 1204, a mouthpiece 1206,

and the above-mentioned liquid crystal panel 100. This liquid crystal panel 100 may be provided with a backlight (not shown in the drawing) at the back face thereof for improving the visibility.

[0090]

<3: Digital Still Camera>

Next, a digital still camera using the liquid crystal device as a finder will be described. Fig. 20 is an isometric view illustrating the configuration of the digital still camera and the connection to external devices in brief.

[0091]

Typical cameras sensitize films based on optical images from objects, whereas the digital still camera 1300 generates imaging signals from the optical image of an object by photoelectric conversion using, for example, a charge coupled device (CCD). The digital still camera 1300 is provided with the liquid crystal panel 100 at the back face of a case 1302 to perform display based on the imaging signals from the CCD. Thus, the liquid crystal panel 100 functions as a liquid crystal finder for displaying the object. A photo acceptance unit 1304 including optical lenses and the CCD is provided at the front side (behind in the drawing) of the case 1302.

[0092]

When a cameraman determines the object image displayed in the liquid crystal panel 100 and releases the shutter 1306, the image signals from the CCD are transmitted and stored to memories in a circuit board 1308. In the digital still camera 1300, video signal output terminals 1312 and input/output terminals 1314 for data communication are provided on a side of the case 1302. As shown in the drawing, a television monitor 1430 and a personal computer 1430 are connected to the video signal output terminals 1312 and the input/output terminals 1314 for data communication, respectively, if necessary. The imaging signals stored in the memories of the circuit board 1308 are output to the television monitor 1430 and the personal computer 1440, by a given operation.

[0093]

Examples of electrooptical devices, other than the personal computer shown in Fig. 18, the portable phone shown in Fig. 19, and the digital still camera shown in Fig. 20, include liquid crystal television sets, view-finder-type and monitoring-type video tape recorders, car navigation systems, pagers, electronic notebooks, portable calculators, word processors, workstations, TV telephones, point-of-sales system (POS) terminals, and devices provided with touch panels. Of course, the above liquid crystal device can be applied to display sections of these electronic devices.

[0094]

[Advantages]

As described above, according to the present invention, when the silver alloy is used as the reflective film in the reflective or transflective liquid crystal device, a decrease in reflectance of the reflective film during the subsequent high-temperature treatment is prevented and the resistance of the leads can be maintained at low levels.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is an isometric view illustrating an overall configuration of a liquid crystal device in accordance with a first embodiment of the present invention.

[Fig. 2]

Fig. 2 is a partial cross-sectional view when a liquid crystal panel constituting the liquid crystal device is broken along the X direction.

[Fig. 3]

Fig. 3 is a partial cross-sectional view when the liquid crystal panel is broken along the Y direction.

[Fig. 4]

Fig. 4 is a plan view illustrating the configuration of a pixel and the configuration of the vicinity of a sealant in the liquid crystal panel.

[Fig. 5]

Fig. 5 is a cross-sectional view taken from line A-A′ in Fig. 4.

[Fig. 6]

Fig. 6 is a partial cross-sectional view illustrating the vicinity of the region for mounting the driver IC chip in the liquid crystal panel.

[Fig. 7]

Fig. 7 is a partial plan view illustrating the vicinity of the region for mounting the driver IC in a backside substrate of the liquid crystal panel.

[Fig. 8]

Figs. 8(a) to 8(e) are cross-sectional views of a manufacturing process of the backside substrate in the liquid crystal panel.

[Fig. 9]

Figs. 9(f) to 9(i) are cross-sectional views of the manufacturing process of the backside substrate in the liquid crystal panel.

[Fig. 10]

Fig. 10 is a graph illustrating reflectance characteristics of silver and aluminum.

[Fig. 11]

Fig. 11 is a partial cross-sectional view when a liquid crystal panel of a liquid crystal panel according to a second embodiment of the present invention is broken along

the X direction.

[Fig. 12]

Fig. 12 is a partial cross-sectional view when the liquid crystal panel is broken along the Y direction.

[Fig. 13]

Figs. 13(a) to 13(f) are cross-sectional views of a manufacturing process of the backside substrate in the liquid crystal panel.

[Fig. 14]

Figs. 14(g) and 14(h) are cross-sectional views of the manufacturing process of the backside substrate in the liquid crystal panel.

[Fig. 15]

Fig. 15 is an isometric view illustrating the configuration of a liquid crystal panel according to a modification of the present invention.

[Fig. 16]

Fig. 16 is an isometric view illustrating the configuration of a liquid crystal panel according to another modification of the present invention.

[Fig. 17]

Fig. 17 is a partial cross-sectional view when a liquid crystal panel according to another modification of the present invention is broken along the X direction.

[Fig. 18]

Fig. 18 is an isometric view of a personal computer as an example of the electronic devices using the liquid crystal panel in accordance with the embodiments.

[Fig. 19]

Fig. 19 is an isometric view of a portable phone as an example of the electronic devices using the liquid crystal panel.

[Fig. 20]

Fig. 20 is an isometric view at the backside of a digital still camera as an example of the electronic devices using the liquid crystal panel.

[Reference Numerals]

100: liquid crystal panel

110: sealant

112: sealant

114: conductive particles (conductors)

122, 124, 126: driver IC chips

129a, 129b: projection electrodes

130, 140: adhesives

134, 144: conductive particles

150: FPC board

160: liquid crystal

200: substrate (first substrate)

202: shading film

204, 205: color filters

208: alignment film

214: common electrode (first transparent electrode)

300: substrate (second substrate)

301: underlying film

302: reflective film

303: protective film

308: alignment film

309: opening

312, 352, 362, 372: reflective conductive films

314: segment electrode (second transparent electrode)

350, 360, 370: leads

354, 364, 374: transparent conductive films

1100: personal computer

1200: portable phone

1300: digital still camera

[Name of Document] ABSTRACT

[Abstract]

[Object] To prevent a decrease in reflectance of a reflective film during a subsequent heat treatment, when a silver alloy is used as the reflective film in a reflective or transflective liquid crystal device.

[Solving Means] A liquid crystal device has a configuration including substrates 200 and 300 bonded to each other with a sealant 110 and a liquid crystal 160 enclosed in the gap therebetween. Common electrodes 214 are provided on the inner face of the substrate 200, whereas an underlying film 301, a reflective film 302 composed of a silver alloy, a protective film 303 covering the reflective film 302, and segment electrodes 314 are provided on the inner face of the backside substrate 300. Since the protective film 303 suppresses the crystal grain growth of the reflective film 302 at a high-temperature treatment, a decrease in reflectance is avoided. A lead 350 comprises laminate of a reflective conductive film 352 having a crystal grain size which is larger than that of the reflective film 302 and a transparent conductive film 354 which is formed by patterning the same layer as the segment electrode 314.

[Selected Figure] Fig. 2

【Name of Document】 Drawings

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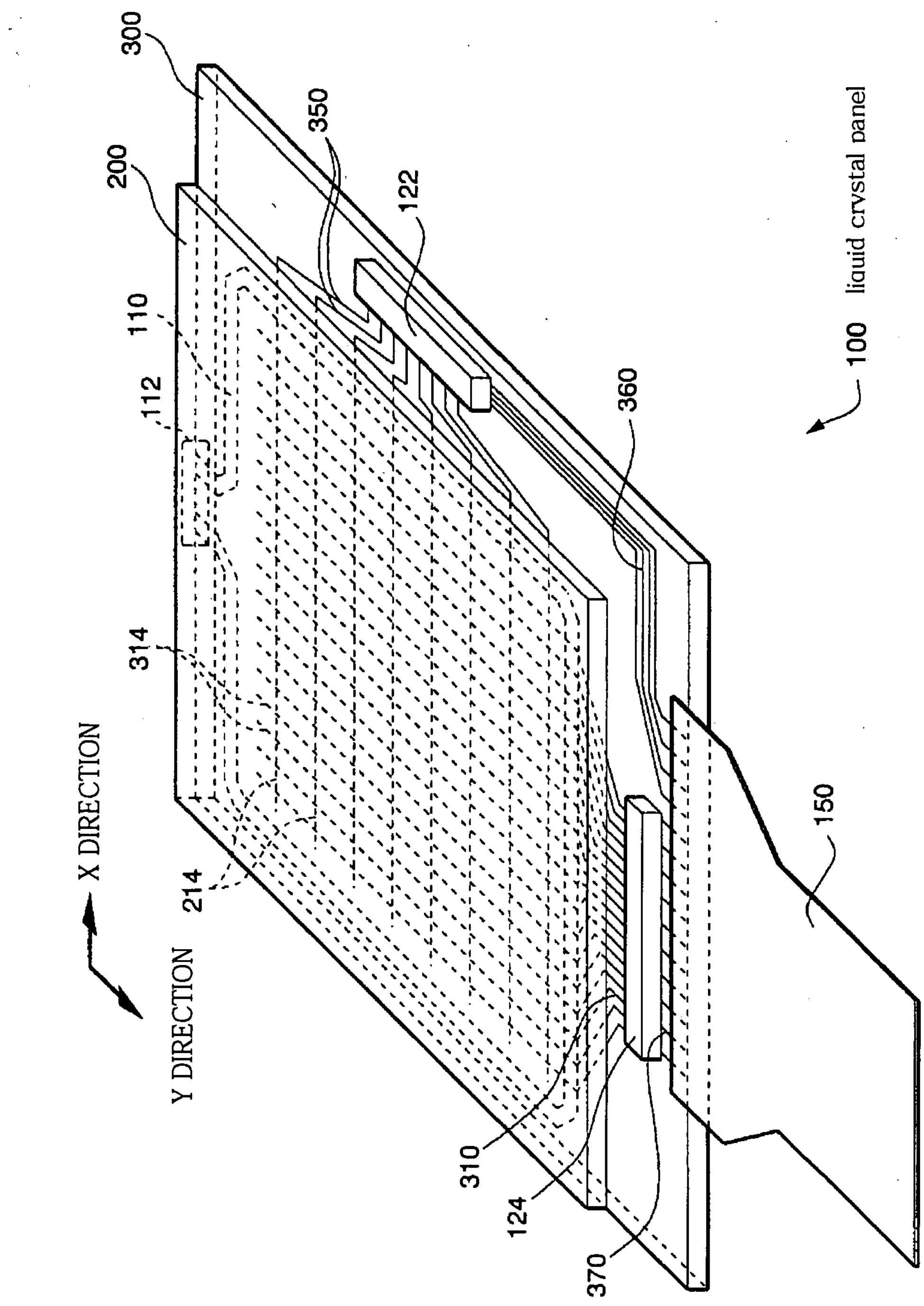

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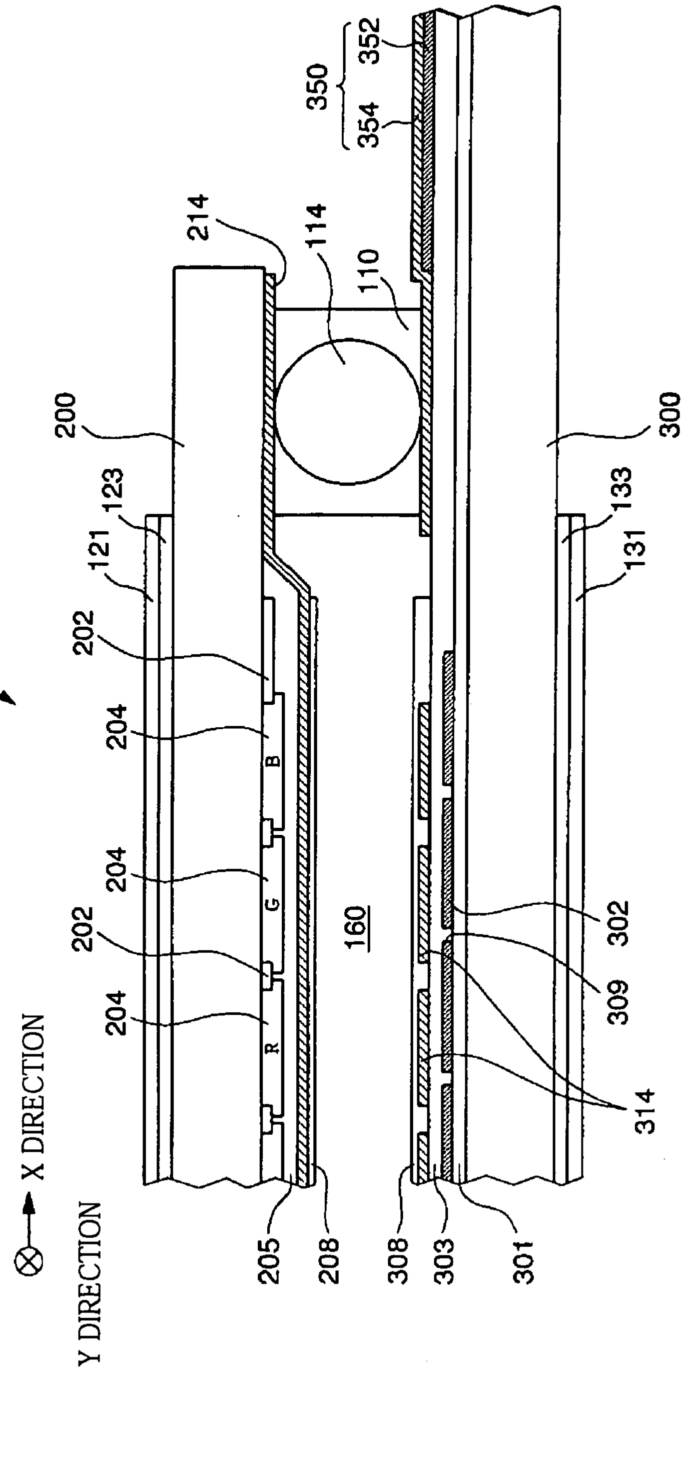
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302
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X DIRECTION
Y DIRECTION

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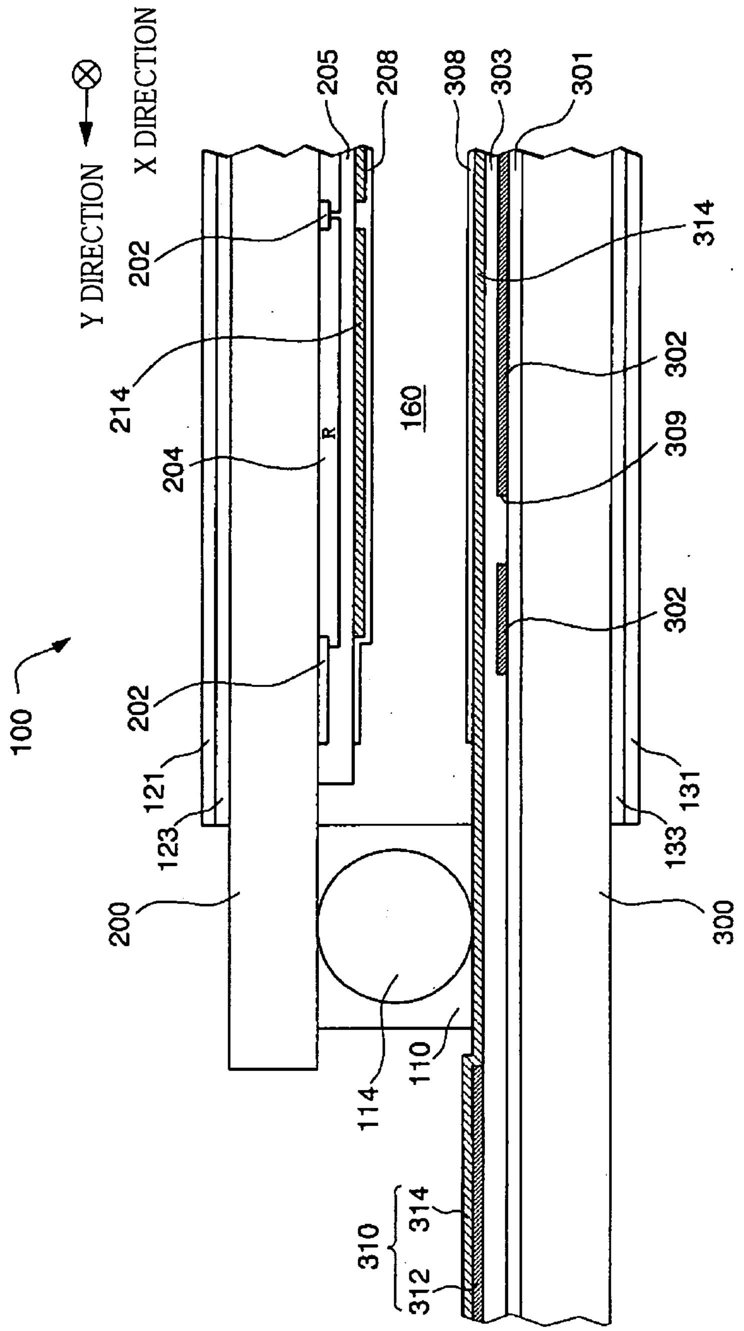
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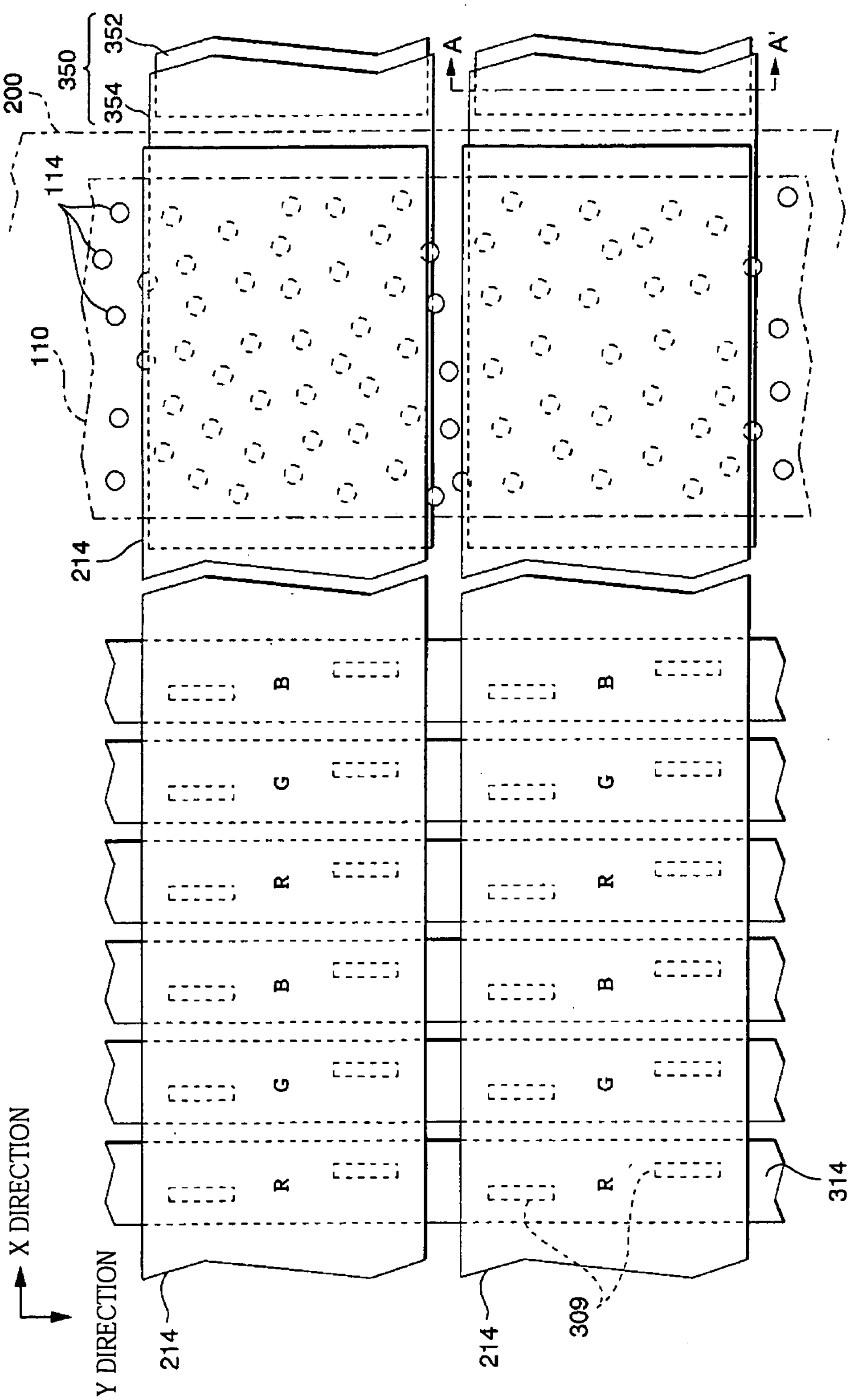
314
312

【F I G. 4】



352
350
354
200
114
110
214
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A'
B
G
R
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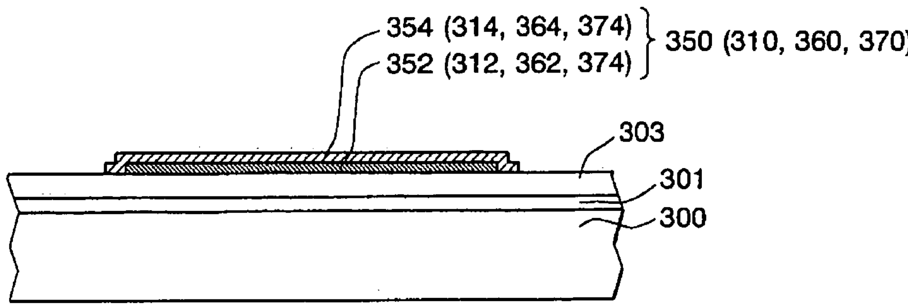
Y DIRECTION
309
314

【F I G. 5】



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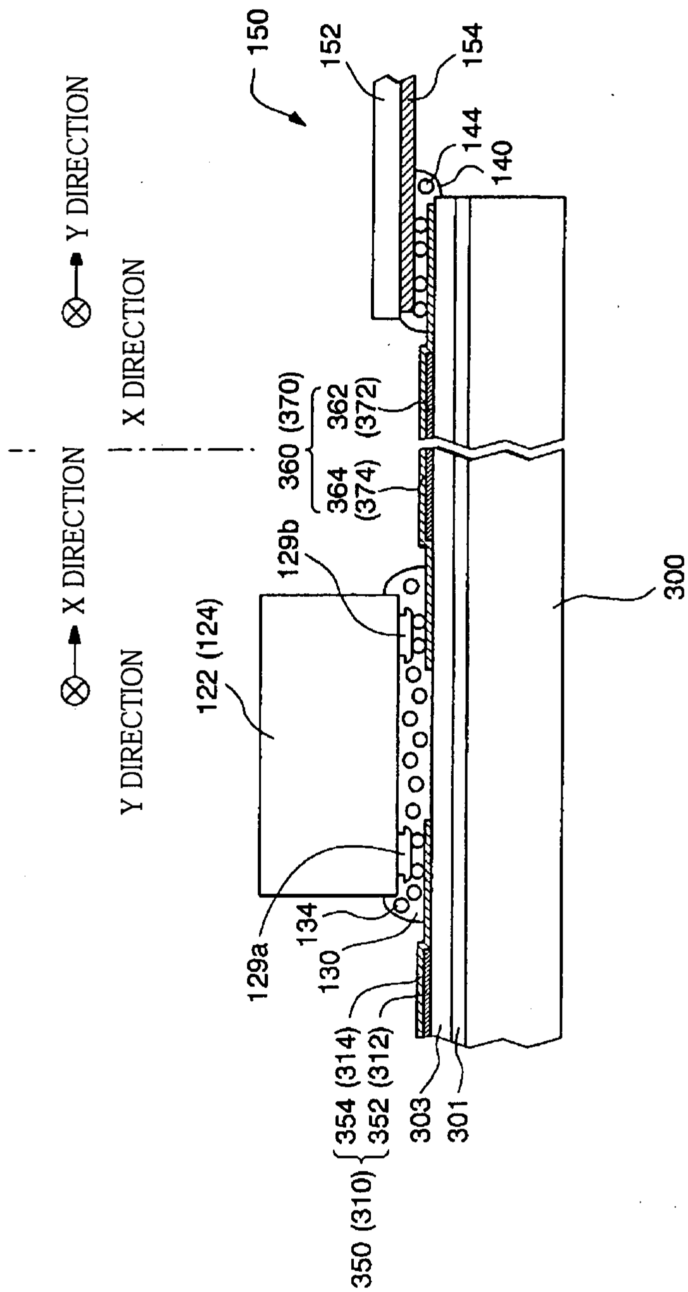
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152
154
144
140
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X DIRECTION
X DIRECTION
Y DIRECTION
360 (370)
362 (372)
364 (374)
129b
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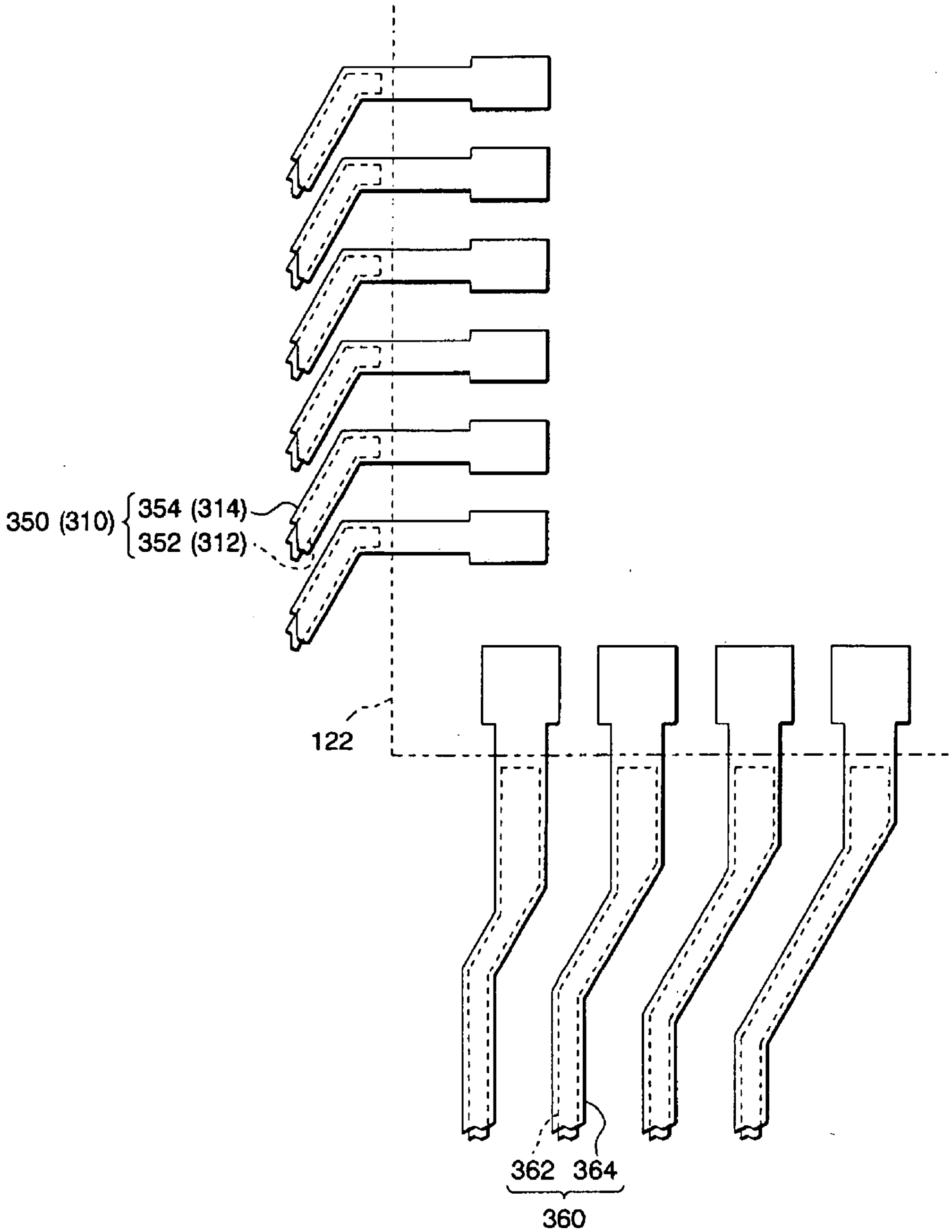
300
129a
134
130
350 (310)
354 (314)
352 (312)
303
301

【FIG. 7】



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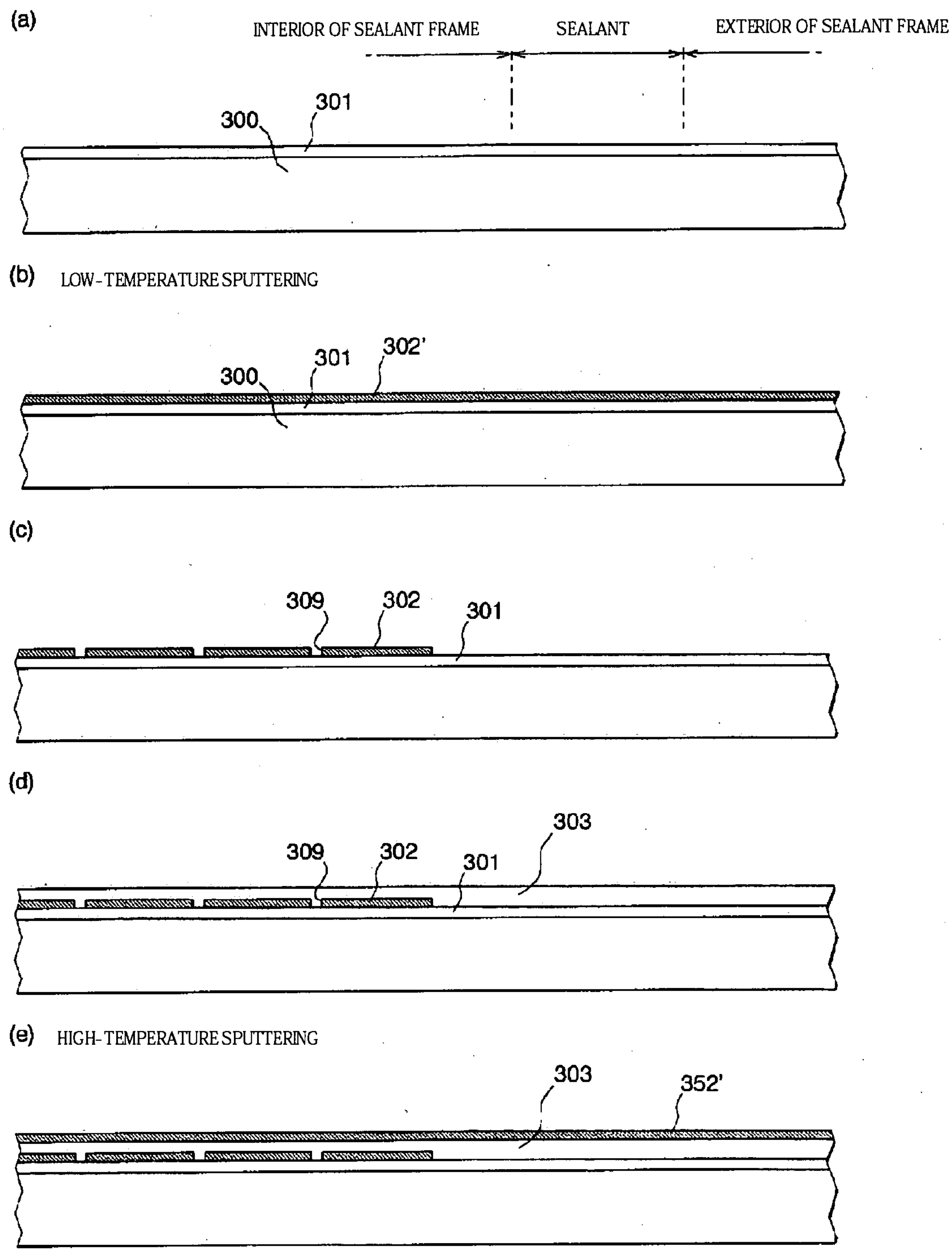
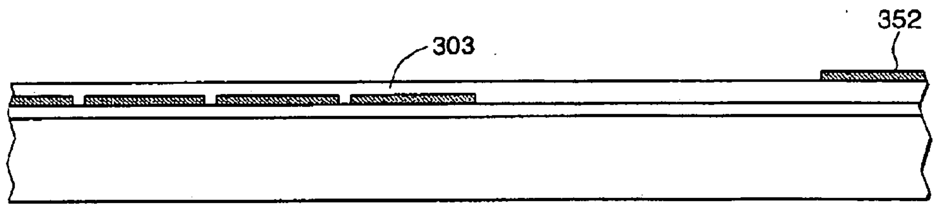
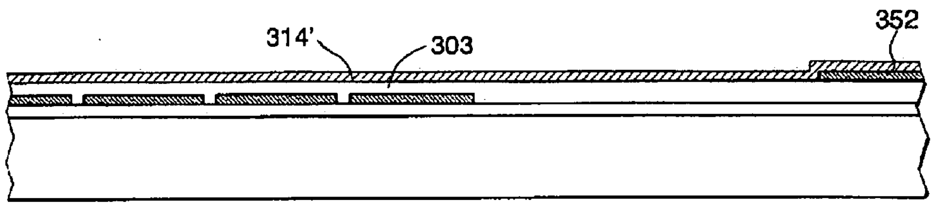

(a)
INTERIOR OF SEALANT FRAME
SEALANT
EXTERIOR OF SEALANT FRAME
300
301
(b)
LOW-TEMPERATURE SPUTTERING
300
301
302'
(c)
309
302
301
(d)
303
309
302
301
(e)
HIGH-TEMPERATURE SPUTTERING
303
352'

【F I G. 9】

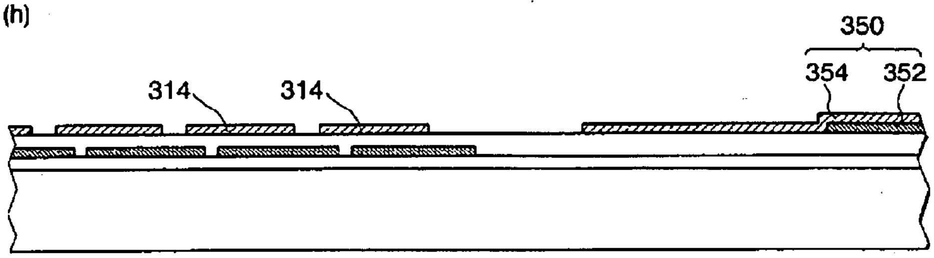
(f)



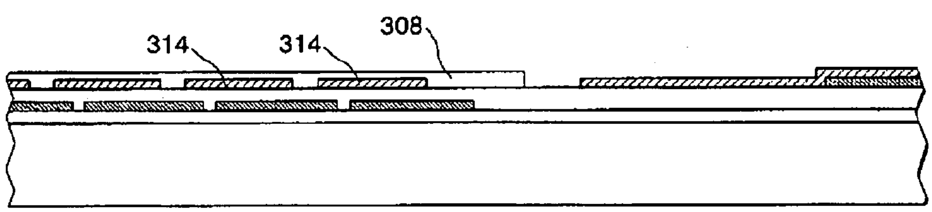
(g)



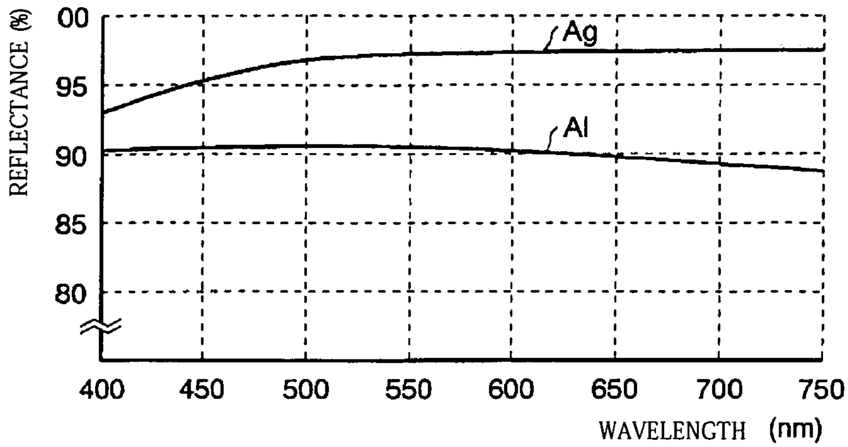
(h)



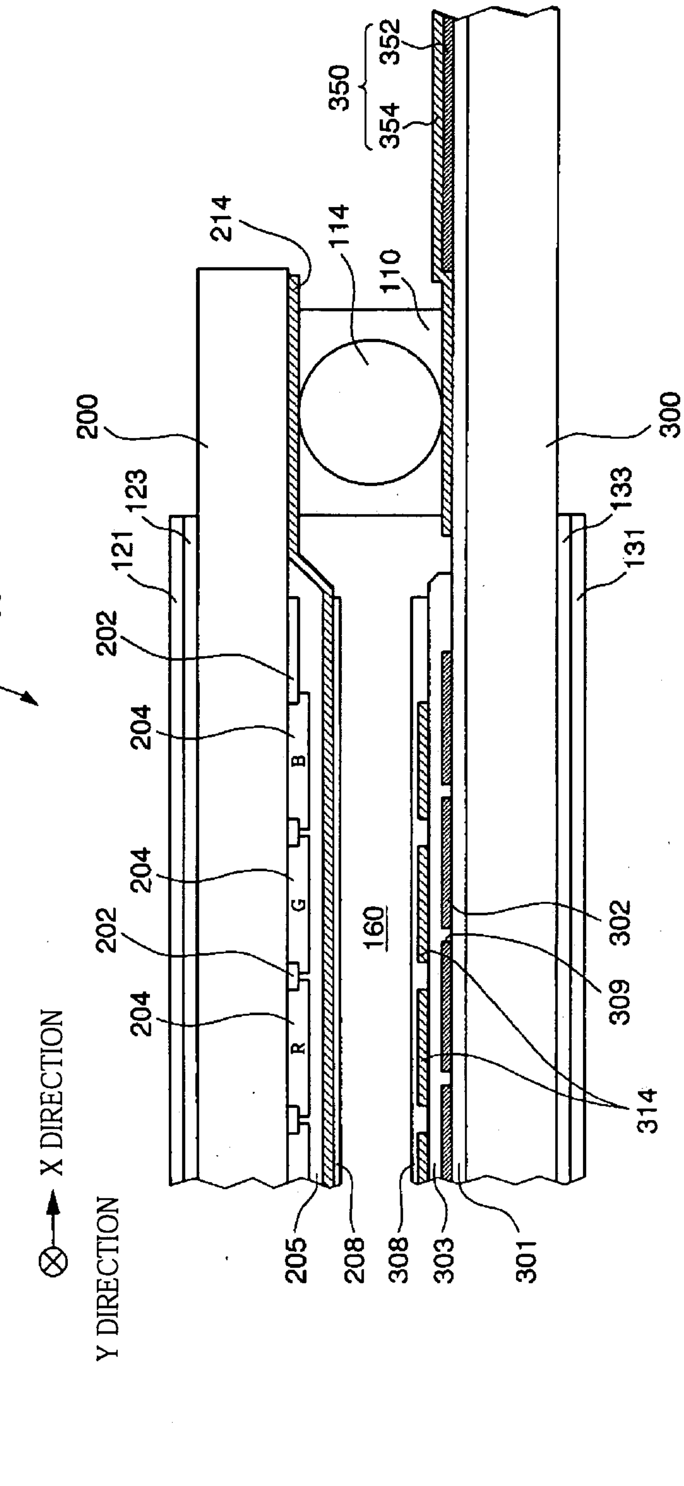
(i)



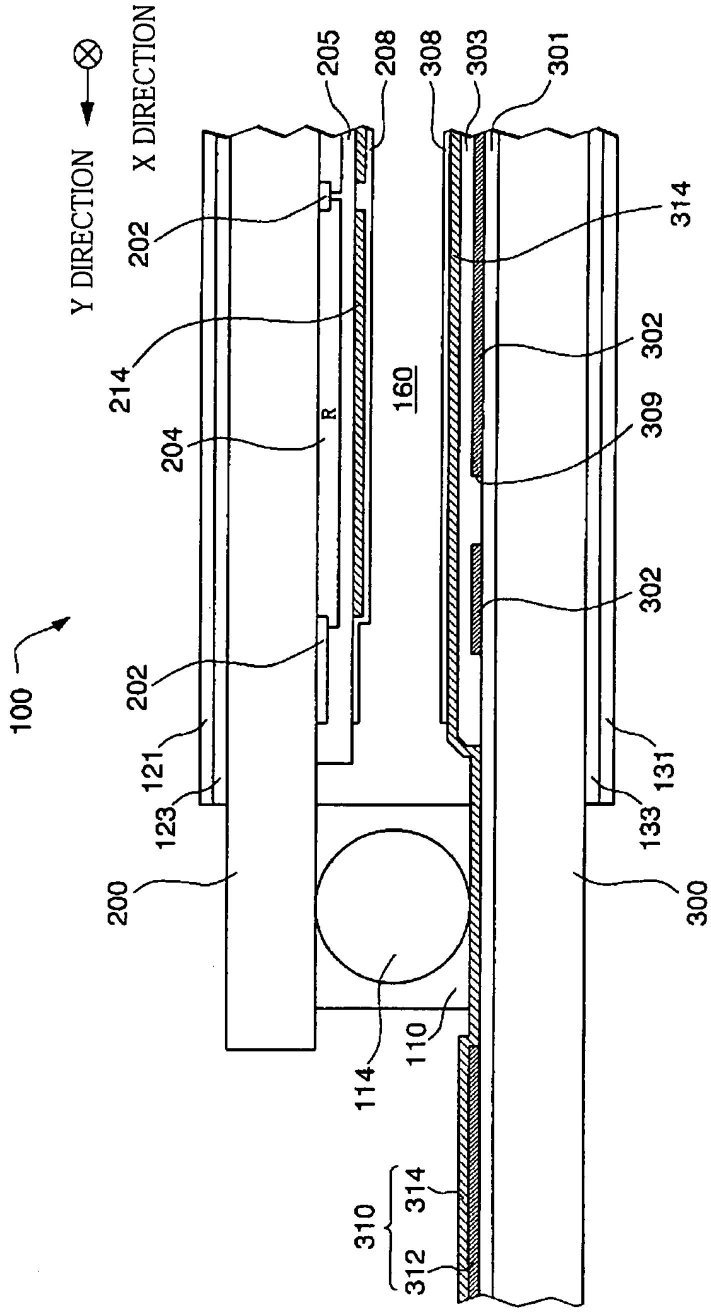
【F I G. 1 0】


REFLECTANCE (%)
00
95
90
85
80
Ag
Al
400
450
500
550
600
650
700
750
WAVELENGTH (nm)

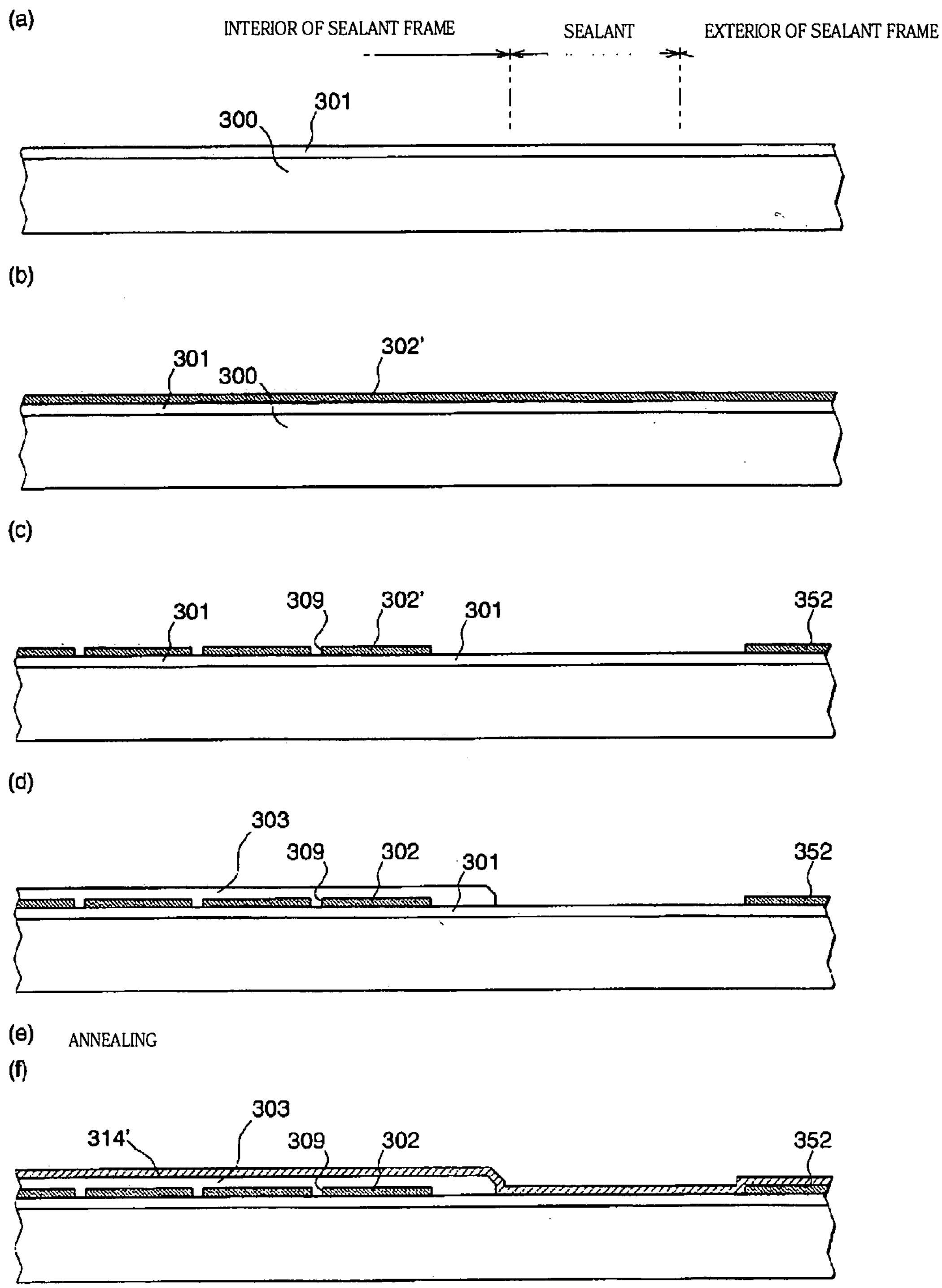
【FIG. 11】


100
200
300
214
114
110
350
352
354
123
121
133
131
202
204
B
G
R
160
302
309
314
205
208
308
303
301
X DIRECTION
Y DIRECTION

【F I G. 1 2】

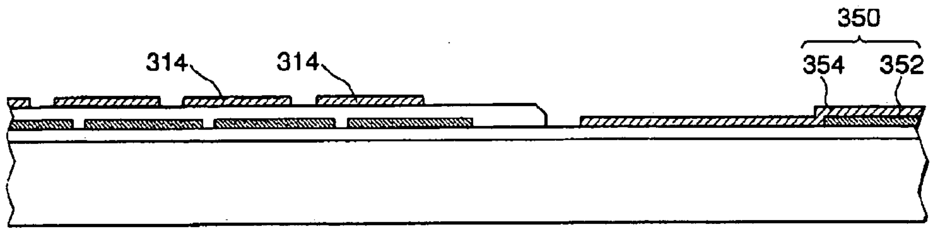

Y DIRECTION
X DIRECTION
205
208
308
303
301
202
314
214
302
160
R
204
309
302
202
100
121
123
131
133
200
300
114
110
310
314
312

【FIG. 13】

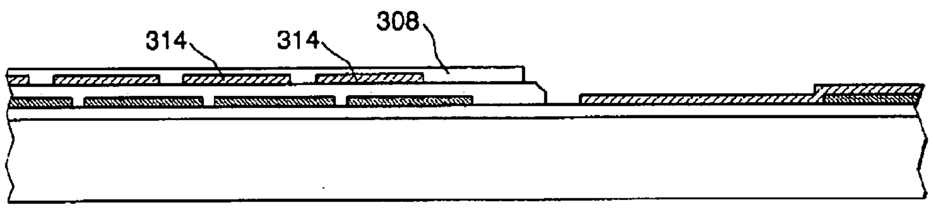

(a)
INTERIOR OF SEALANT FRAME
SEALANT
EXTERIOR OF SEALANT FRAME
300
301
(b)
301
300
302'
(c)
301
309
302'
301
352
(d)
303
309
302
301
352
(e) ANNEALING
(f)
303
314'
309
302
352

【F I G. 1 4】

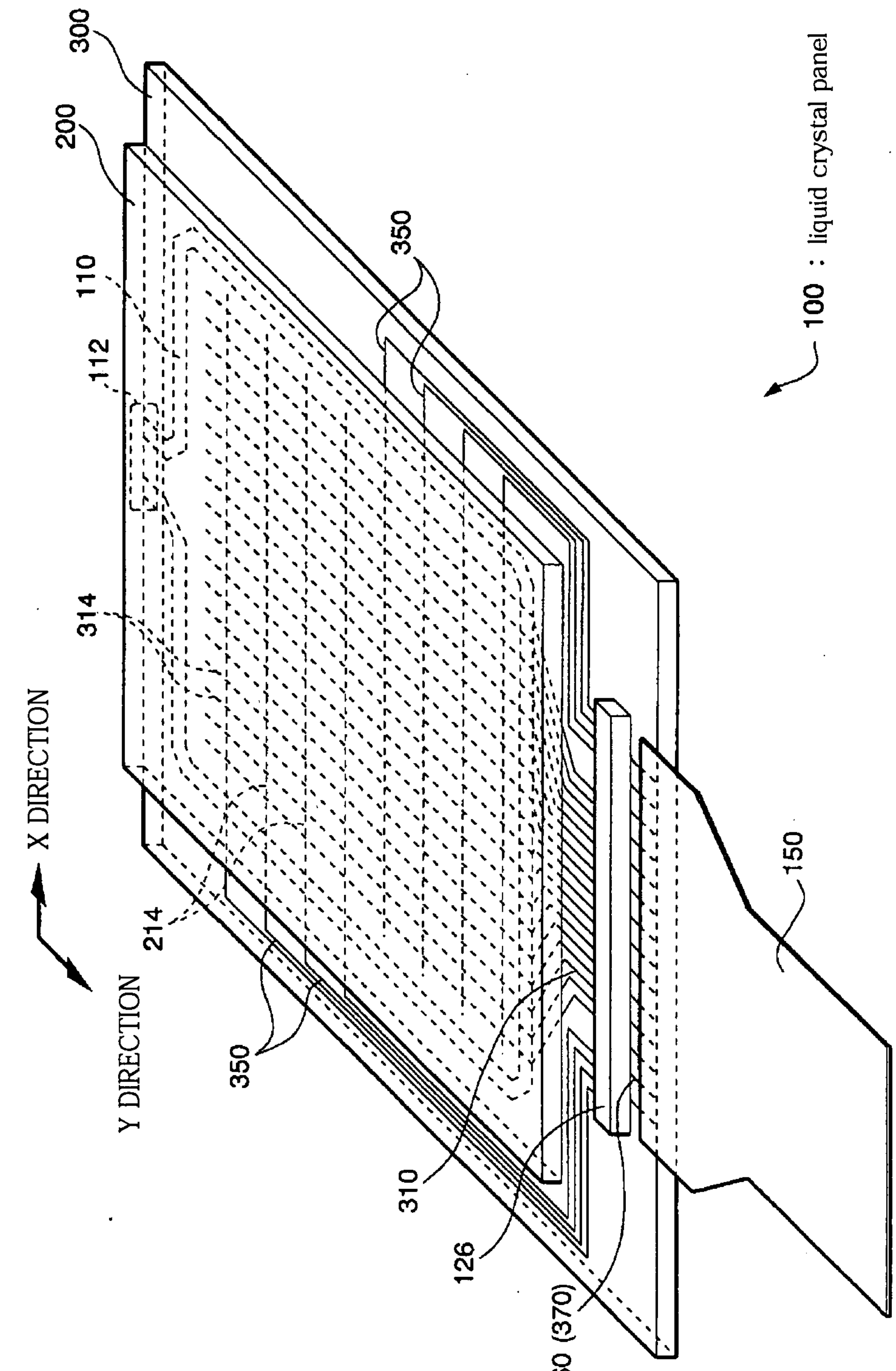
(g)



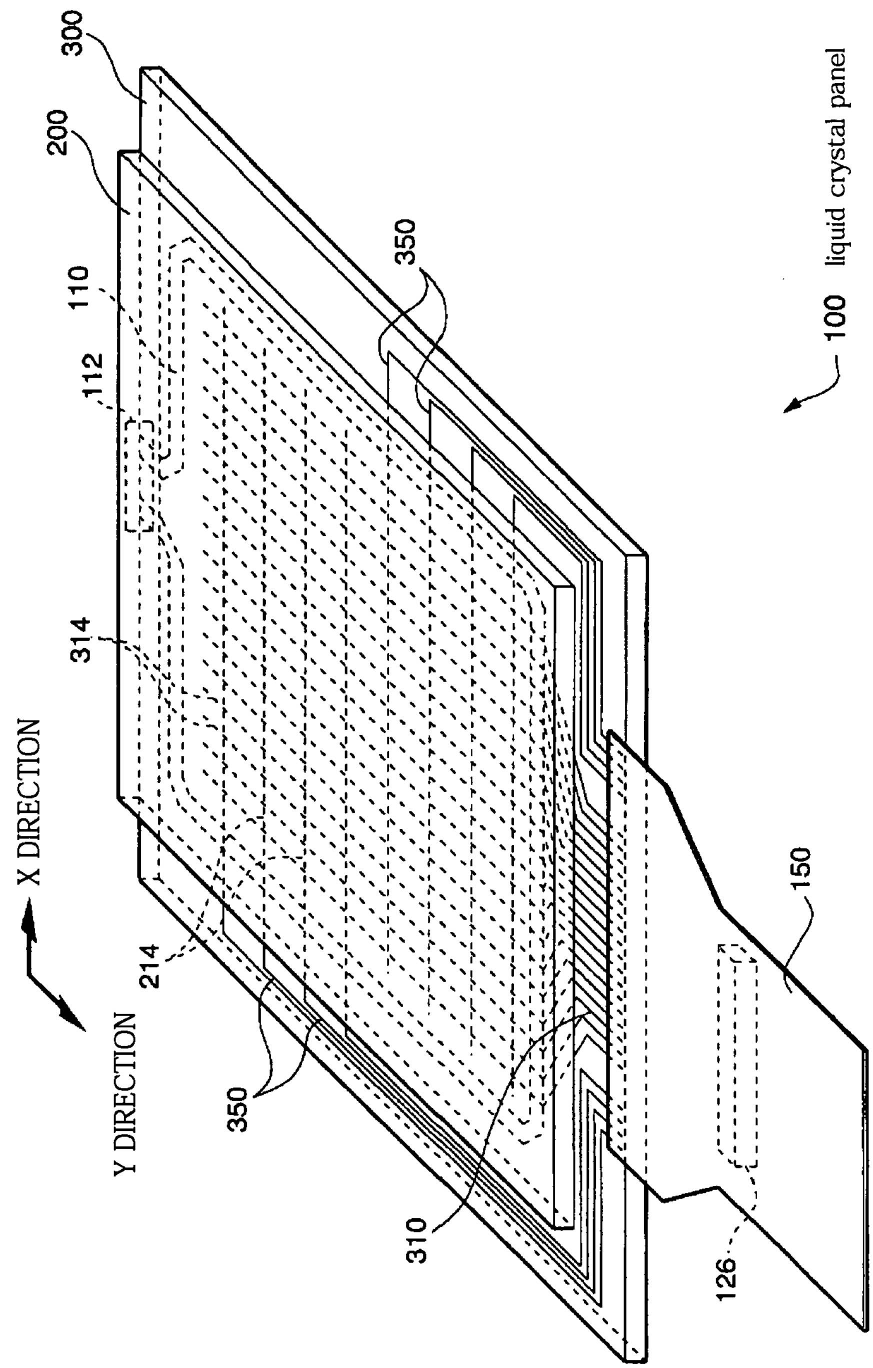
(h)



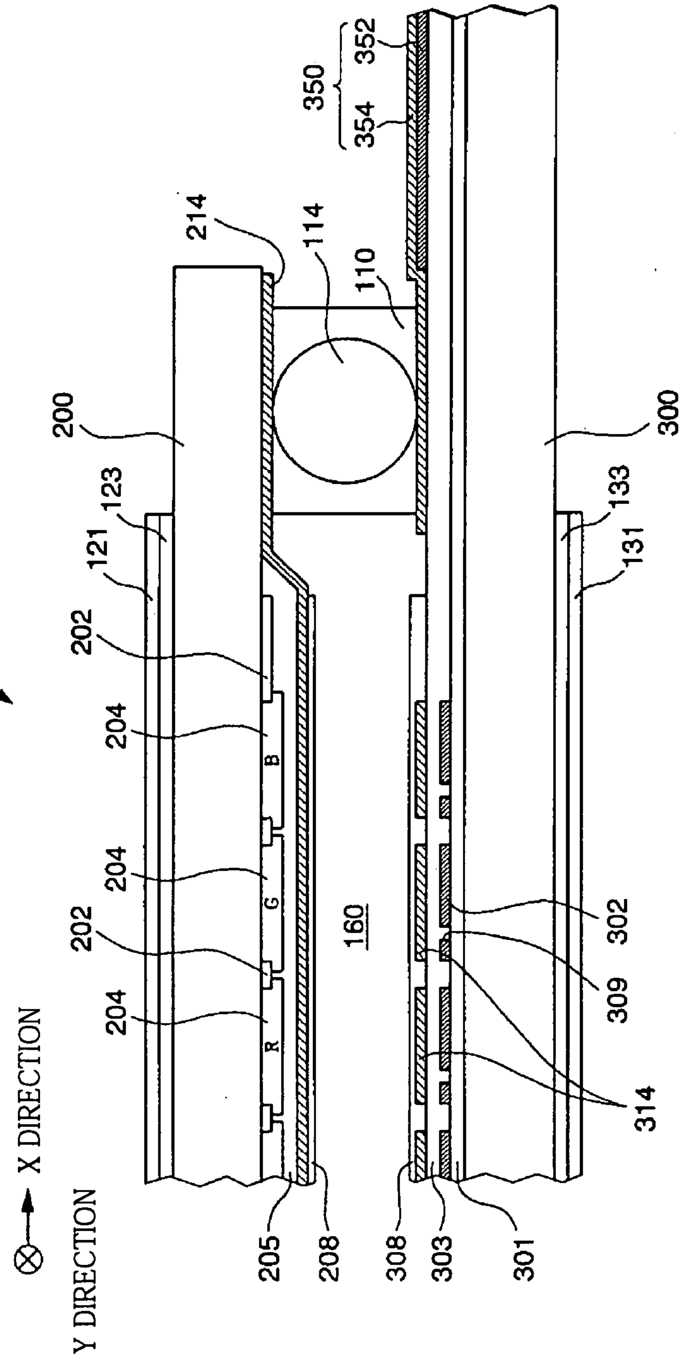
【F I G. 1 5】


300
200
110
112
314
X DIRECTION
Y DIRECTION
214
350
350
310
126
360 (370)
150
100 : liquid crystal panel

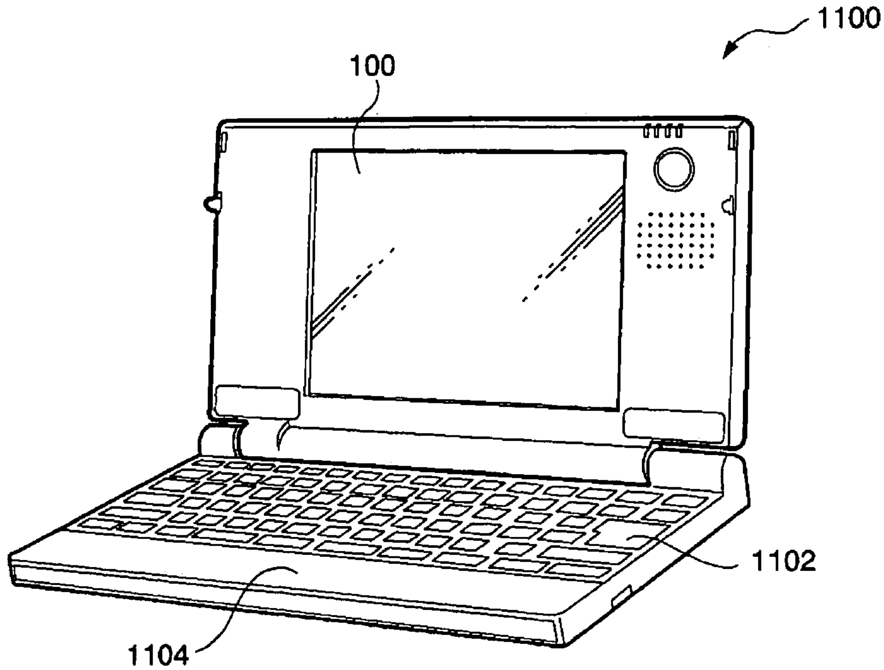
【F I G. 1 6】


300
200
110
112
314
X DIRECTION
Y DIRECTION
214
350
350
310
126
150
100
liquid crystal panel

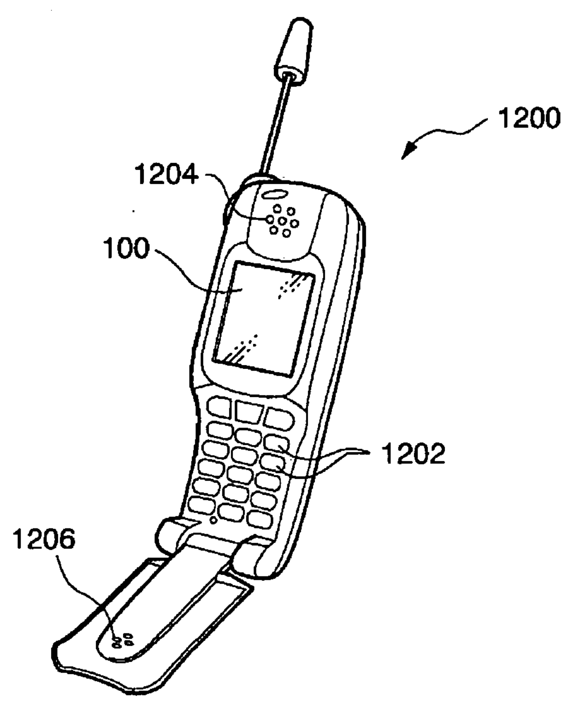
【F I G. 1 7】


100
121
123
200
202
204
B
G
R
205
208
214
114
110
350
352
354
300
133
131
160
302
309
314
308
303
301
X DIRECTION
Y DIRECTION

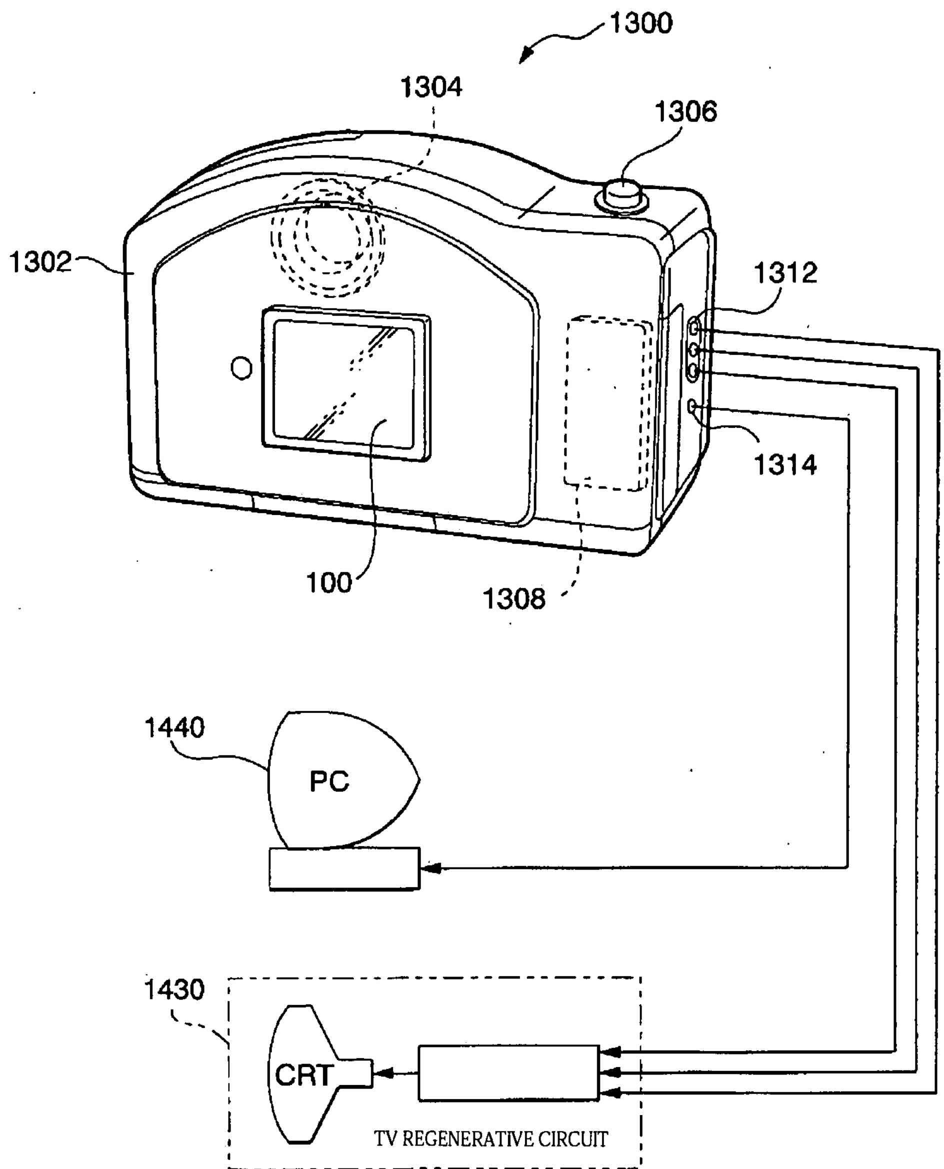
【FIG. 18】



【FIG. 19】



【F I G. 2 0】


1300
1304
1306
1302
1312
1314
100
1308
1440
PC
1430
CRT
TV REGENERATIVE CIRCUIT